IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Simon Barakat	§	Group Art Unit: 2837
	§	
Serial Number: 10/532,644	§	Examiner: Scott Hughes
	§	
Confirmation Number: 6256	§	Atty Dkt No.: 14.0225-PCT-US
	§	
Filing Date: August 10, 2006	§	
	§	
Entitled: SEISMIC ACQUISITION SYSTEM	§	
	§	

Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Index of documents

accompanied a request for participation in the Patent Prosecution Highway (PPH) Pilot Program between the UKIPO and the USPTO.

1. The request (2 pages)
2. **This index (1 page)**
3. Preliminary amendment (5 pages)
4. Search report from UK IPO, 6 May, 2003 (8 pages, including a cover)
5. First examination report from UK IPO, 25 Oct., 2005 (5 pages, including a cover)
6. Second examination report from UK IPO, 15 Feb., 2007 (8 pages, including a cover)
7. Third examination report from UK IPO, 25 April, 2007 (4 pages, including a cover)
8. Notification of Grant, 24 July 2007, (3 pages including a cover)
9. UK patent, GB 2 395 630 B (28 pages including a cover)
10. Non-US references cited by GB search report, WO98/18022(Vibration Technology) and WO98/07049(Petroleum Geo-Services). These references were disclosed in an IDS filed on 1/11/2007, among other references. (78 pages, including a cover).

PTO/SB/20 (09-07)
Approved for use through 12/31/2008. OMB 0651-0058
U.S. Patent and Trademark Office; U.S DEPARTMENT OF COMMERCE

REQUEST FOR PARTICIPATION IN THE PATENT PROSECUTION HIGHWAY (PPH) PILOT PROGRAM BETWEEN THE (1) JPO OR (2) UKIPO, AND THE USPTO

Application No.:	10/532,644	First Named Inventor.	Simon Barakat
Filing Date:	Agu. 10, 2006	Attorney Docket No.:	14.0225-PCT-US
Title of the Invention.	SEISMIC ACQUISITION SYSTEM		

THIS REQUEST FOR PARTICIPATION IN THE PPH PILOT PROGRAM MUST BE FAXED TO:
THE OFFICE OF THE COMMISSIONER FOR PATENTS AT 571-273-0125 DIRECTED TO THE ATTENTION OF MAGDALEN GREENLIEF

APPLICANT HEREBY REQUESTS PARTICIPATION IN THE PATENT PROSECUTION HIGHWAY (PPH) PILOT PROGRAM AND PETITIONS TO MAKE THE ABOVE-IDENTIFIED APPLICATION SPECIAL UNDER THE PPH PILOT PROGRAM.

The above-identified application validly claims priority under 35 U.S.C. 119(a) and 37 CFR 1 55 to one or more corresponding JPO application(s) or UKIPO application(s).

The ☐ JPO ☒ UKIPO application number(s) is/are: 0227293.8

The filing date of the ☐ JPO ☒ UKIPO application(s) is/are: 22 Nov., 2002

I. List of Required Documents:

a **A copy of all JPO office actions (excluding "Decision to Grant a Patent"*) in the above-identified JPO application(s), or a copy of all UKIPO office actions in the above-identified UKIPO application(s).**

☒ Is attached.

☐ Is available via Dossier Access System. Applicant hereby requests that the USPTO obtain these documents via the Dossier Access System.

*It is not necessary to submit a copy of the "Decision to Grant a Patent" and an English translation thereof.

b. **A copy of all claims which were determined to be patentable by the JPO in the above-identified JPO application(s), or a copy of all claims which were determined to be patentable by the UKIPO in the above-identified UKIPO application(s).**

☒ Is attached.

☐ Is available via Dossier Access System. Applicant hereby requests that the USPTO obtain these documents via the Dossier Access System.

c. **English translations (where applicable) of the documents in a. and b. above along with a statement that the English translations are accurate are attached.**

Information disclosure statement listing the documents cited in the JPO office actions or UKIPO office actions is attached.

Copies of all documents are attached except for U.S. patents or U.S. patent application publications.

PTO/SB/20 (09-07)
Approved for use through 12/31/2008. OMB 0651-0058
U.S. Patent and Trademark Office; U.S DEPARTMENT OF COMMERCE

REQUEST FOR PARTICIPATION IN THE PATENT PROSECUTION HIGHWAY (PPH) PILOT PROGRAM BETWEEN THE (1) JPO OR (2) UKIPO, AND THE USPTO
(continued)

Application No..	10/532,644	First Named Inventor	Simon Barakat

II. Claims Correspondence Table:

Claims in US Application	Patentable Claims in JP/UKIPO Application	Explanation regarding the correspondence
1, 3-17, 2, 3, 18, 20-25, 19	1, 2-15, 16, 17, 38, 39-44, 45	Claims 1-17, 38-45 in the US application are identical to the claims in the UK granted patent as referenced on the left.

III. All the claims in the US application sufficiently correspond to the patentable/allowable claims in the JPO or UKIPO application.

IV. Payment of Fees:

The Commissioner is hereby authorized to charge the petition fee under 37 CFR 1.17(h) as required by 37 CFR 1.102(d) to ☒ **Deposit Account No.** 50-1720.

☐ **Credit Card. Credit Card Payment Form (PTO-2038) is attached.**

Signature		Date 9/26/2007
Name (Print/Typed)	Liangang (Mark) Ye	48,276 Registration Number

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(45) Date of publication: 22.08.2007

(54) Title of the invention: Seismic acquisition system

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H4L LRAXA L201 L203 L204 L209 L211 L213 L215 L217 L221
U1S S2141

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WO 1998/016022 A1
WO 1998/007049 A2
JP 100031075 A
US 6226601 B1
US 5706250 A
US 5627798 A
US 3886494 A

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INT CL[7] G01V, G06C, H04B, H04L, H04Q
Other
ONLINE: WPI, JAPIO, EPODOC
updated as appropriate

Additional Fields
INT CL G01V
Other
Online : wpi ; epodoc

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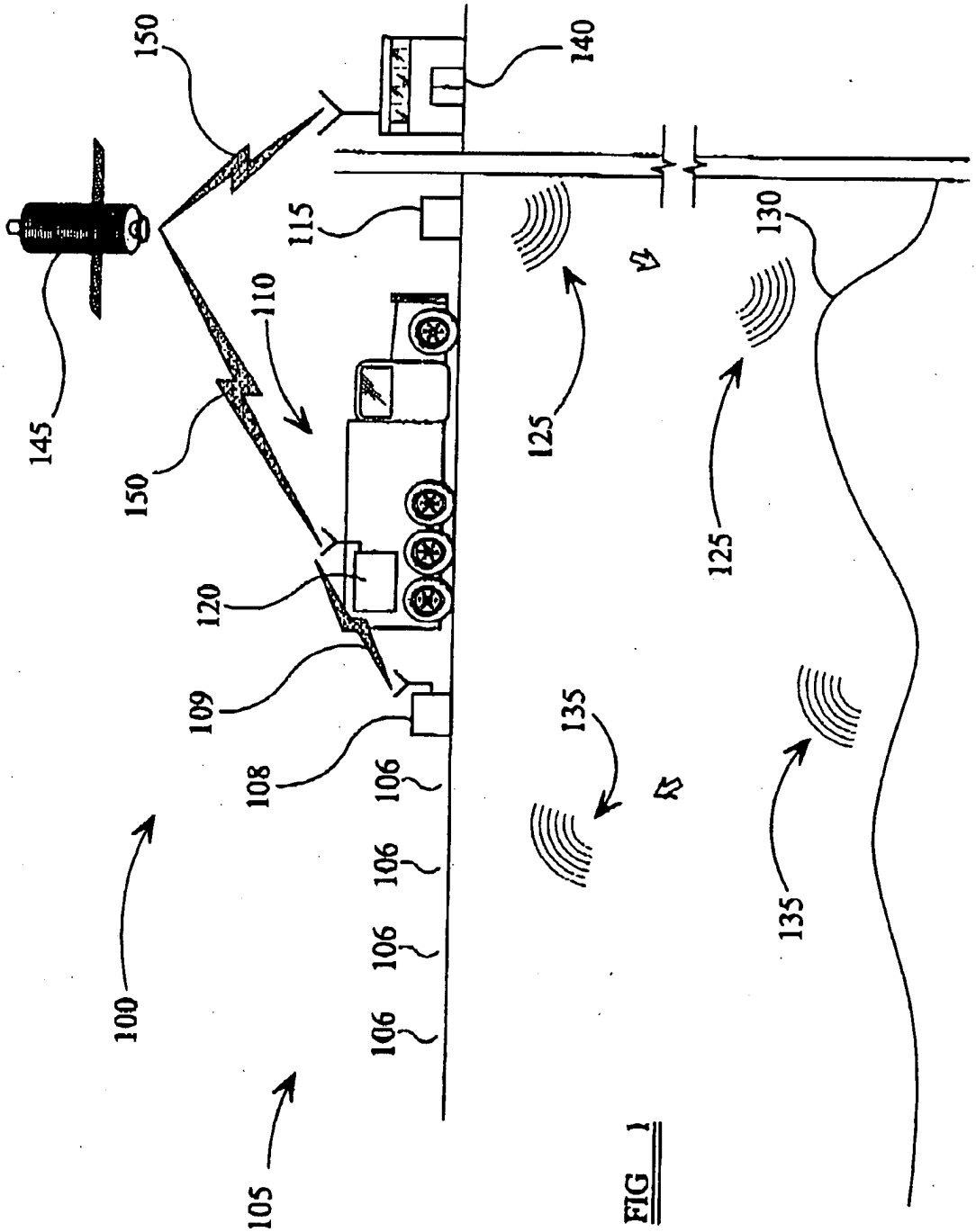
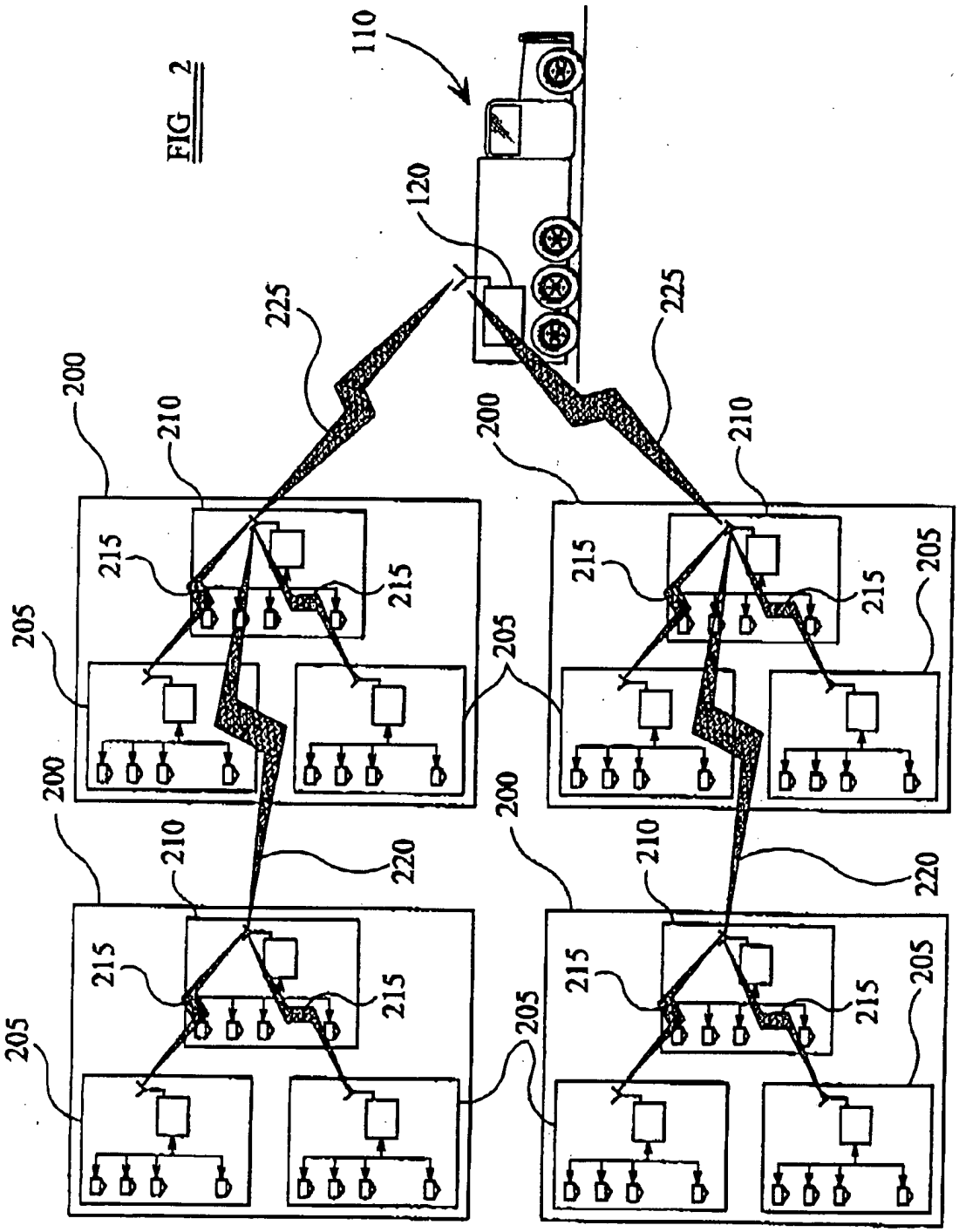

150
140
115
110
145
150
120
109
108
106
106
106
106
100
105
125
130
125
135
135

FIG 1

FIG 2



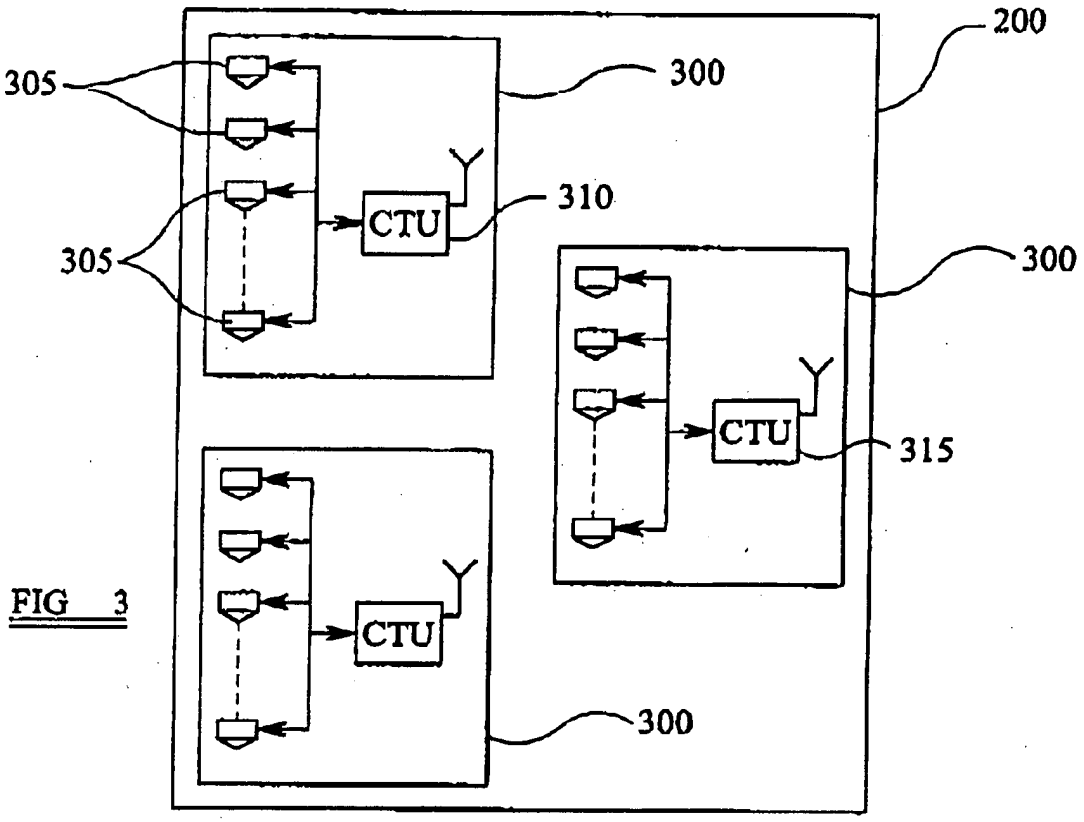


FIG 3

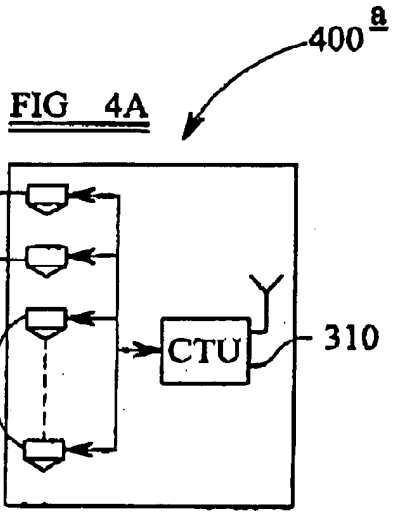


FIG 4A

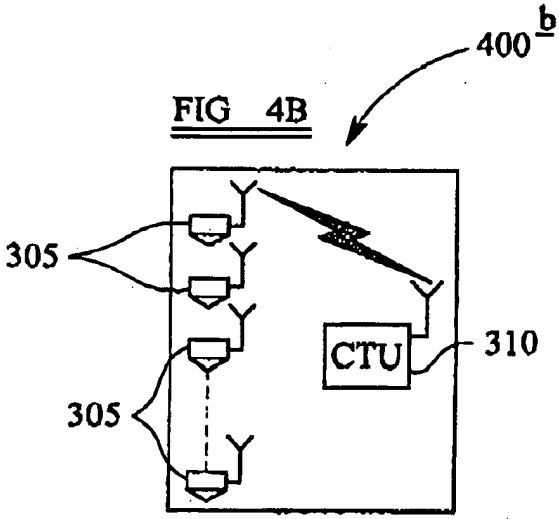
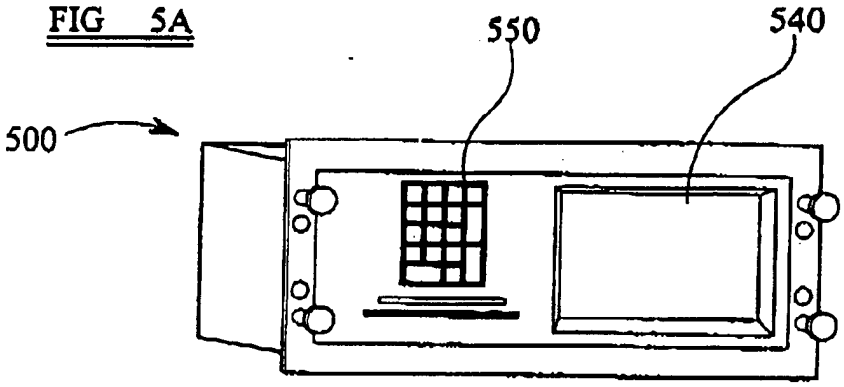


FIG 4B

11 +2 04

FIG 5A



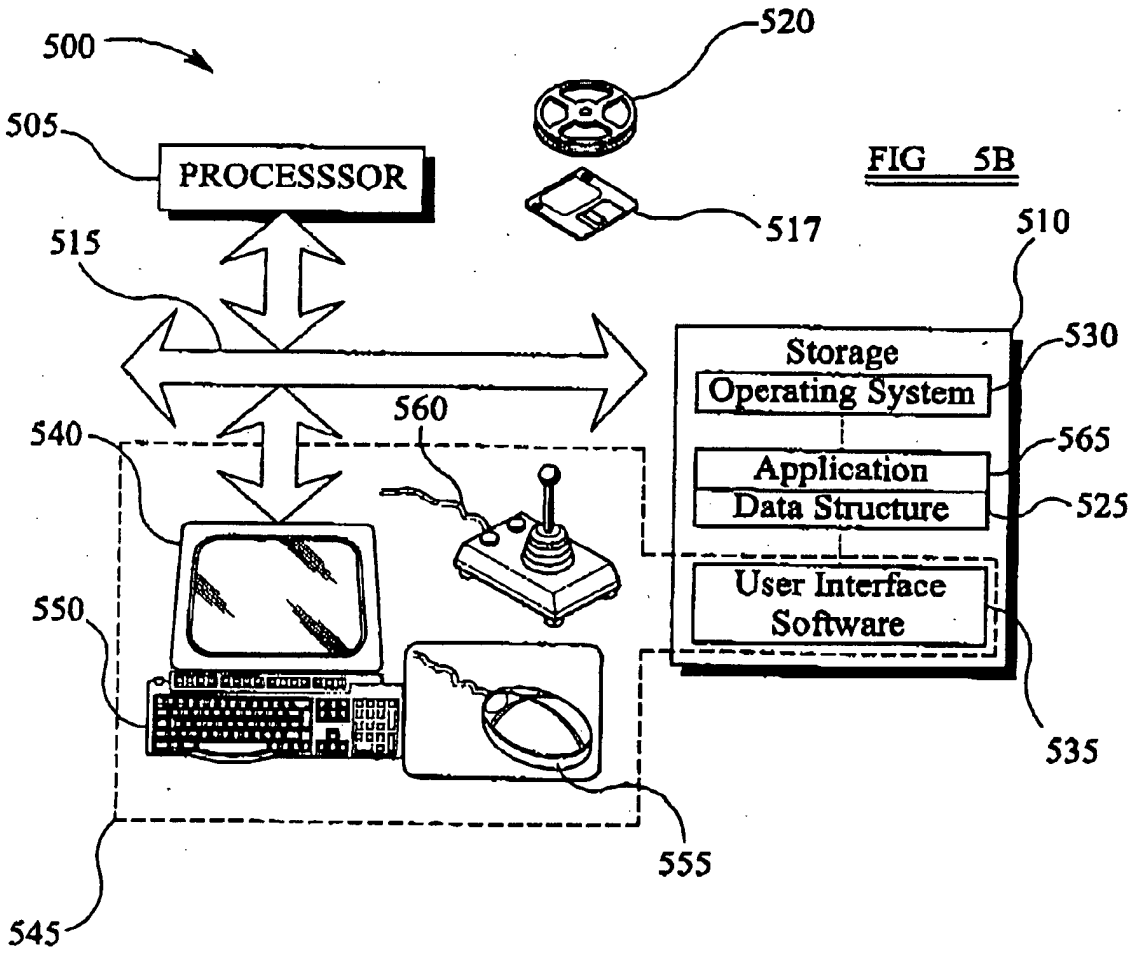


FIG 5B

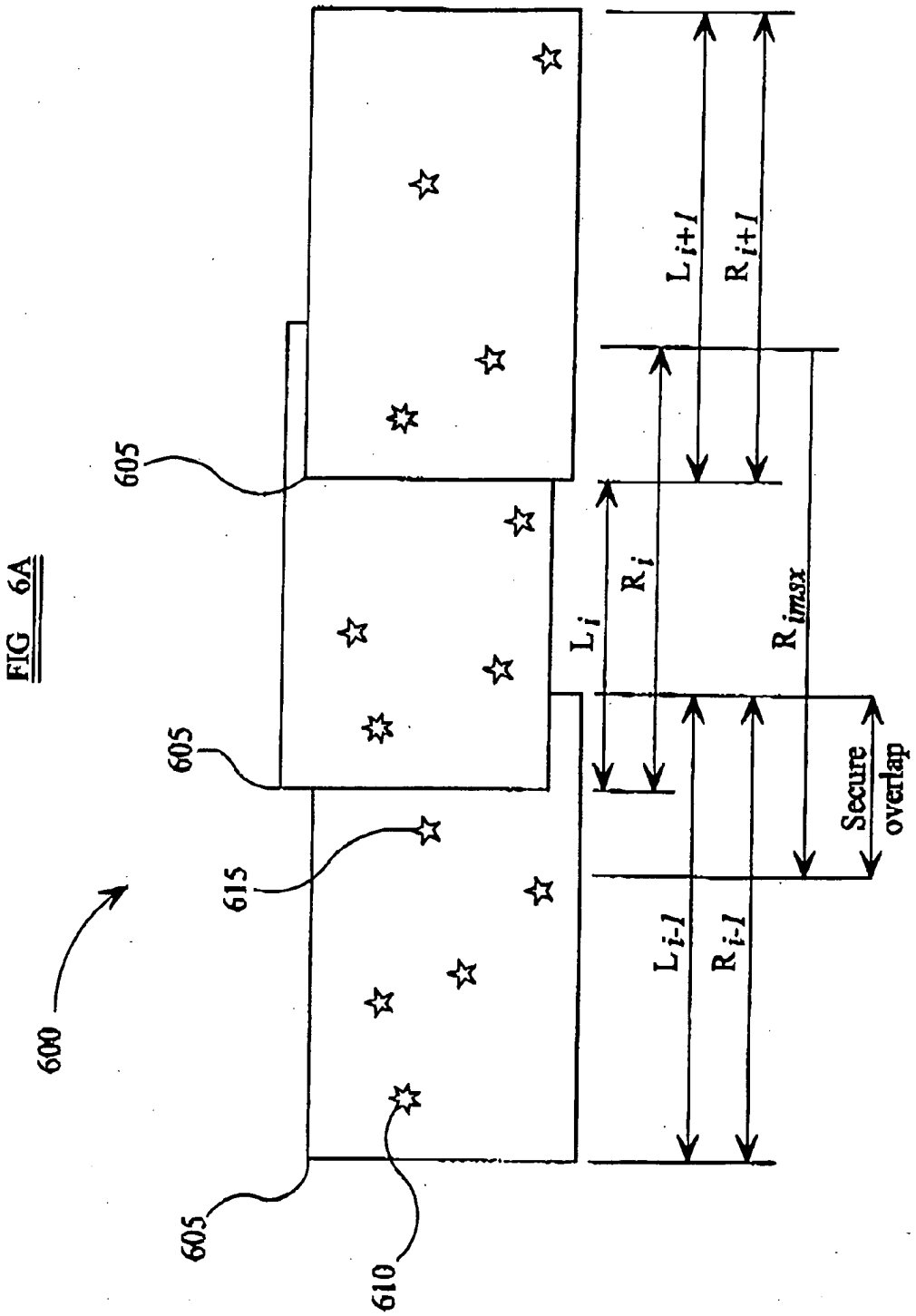

600
605
605
605
610
615
L_{i+1}
R_{i+1}
L_i
R_i
R_{imax}
Secure overlap
L_{i-1}
R_{i-1}

FIG 6A

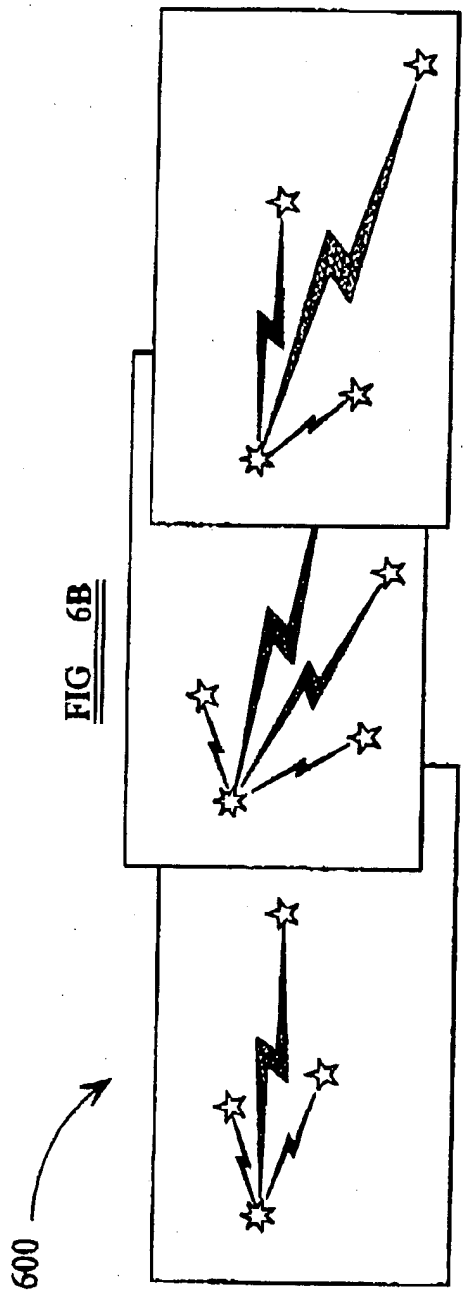


FIG 6B

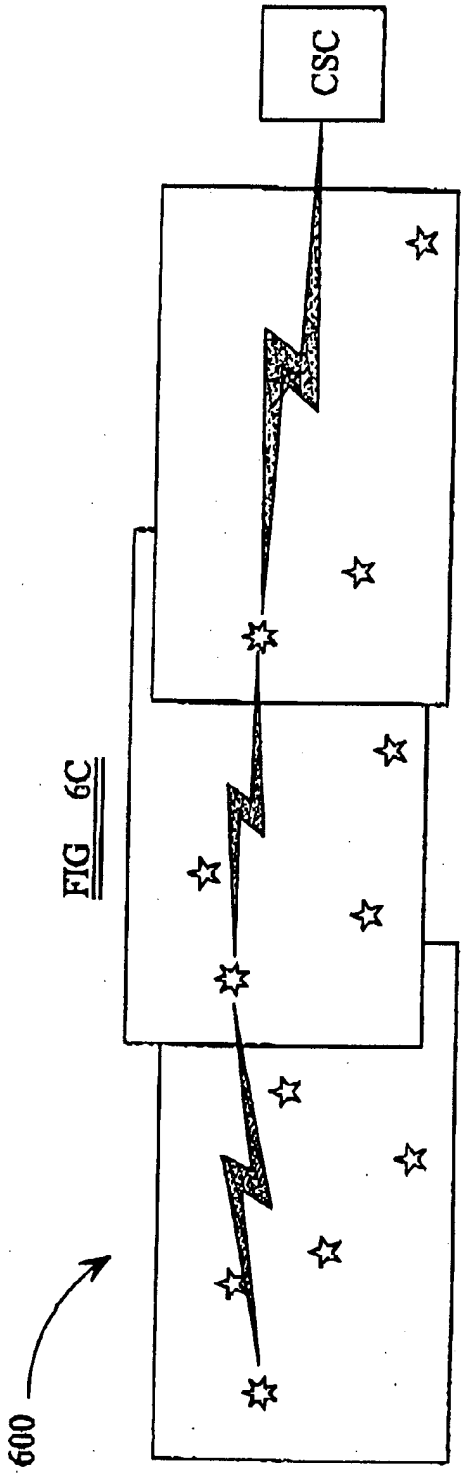
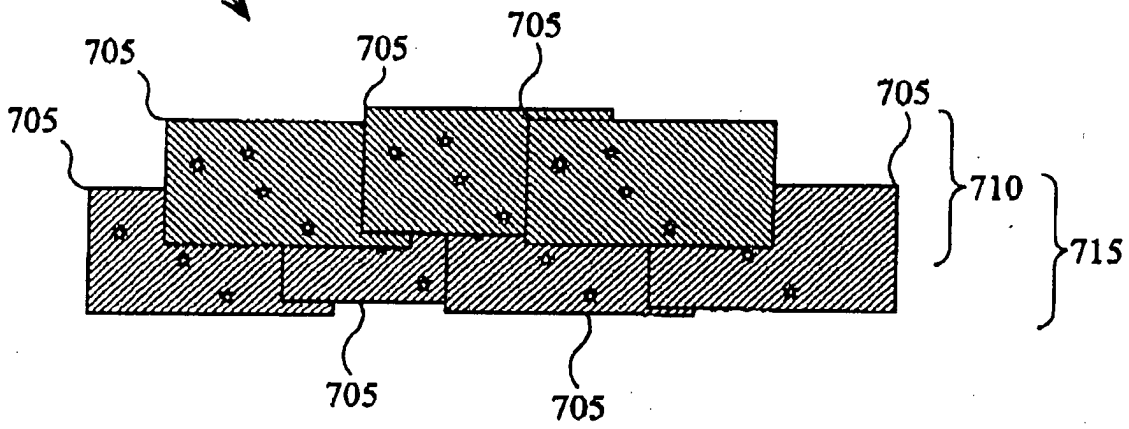


FIG 6C

FIG 7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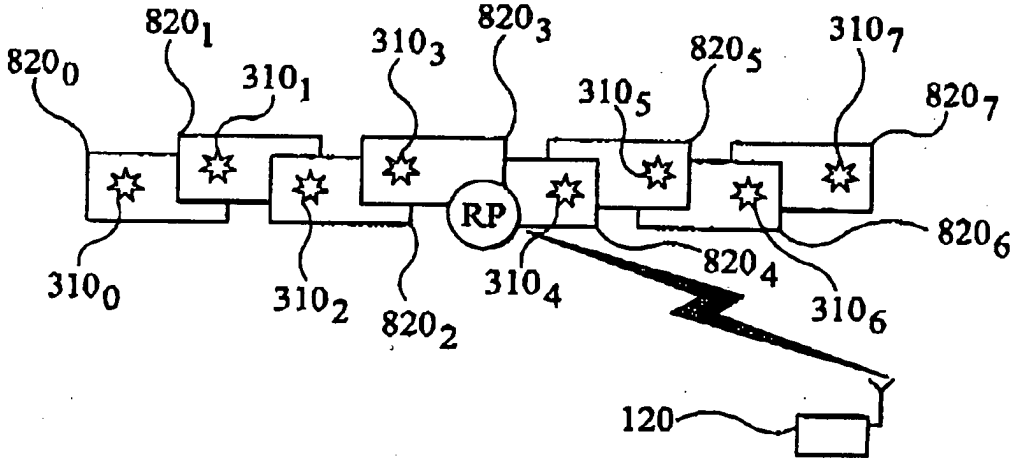
705
705
705
705
705
705
705
710
715
705
705

FIG 8B


820$_0$
820$_1$
310$_1$
310$_3$
820$_3$
310$_5$
820$_5$
310$_7$
820$_7$
RP
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310$_2$
820$_2$
310$_4$
820$_4$
310$_6$
820$_6$
120

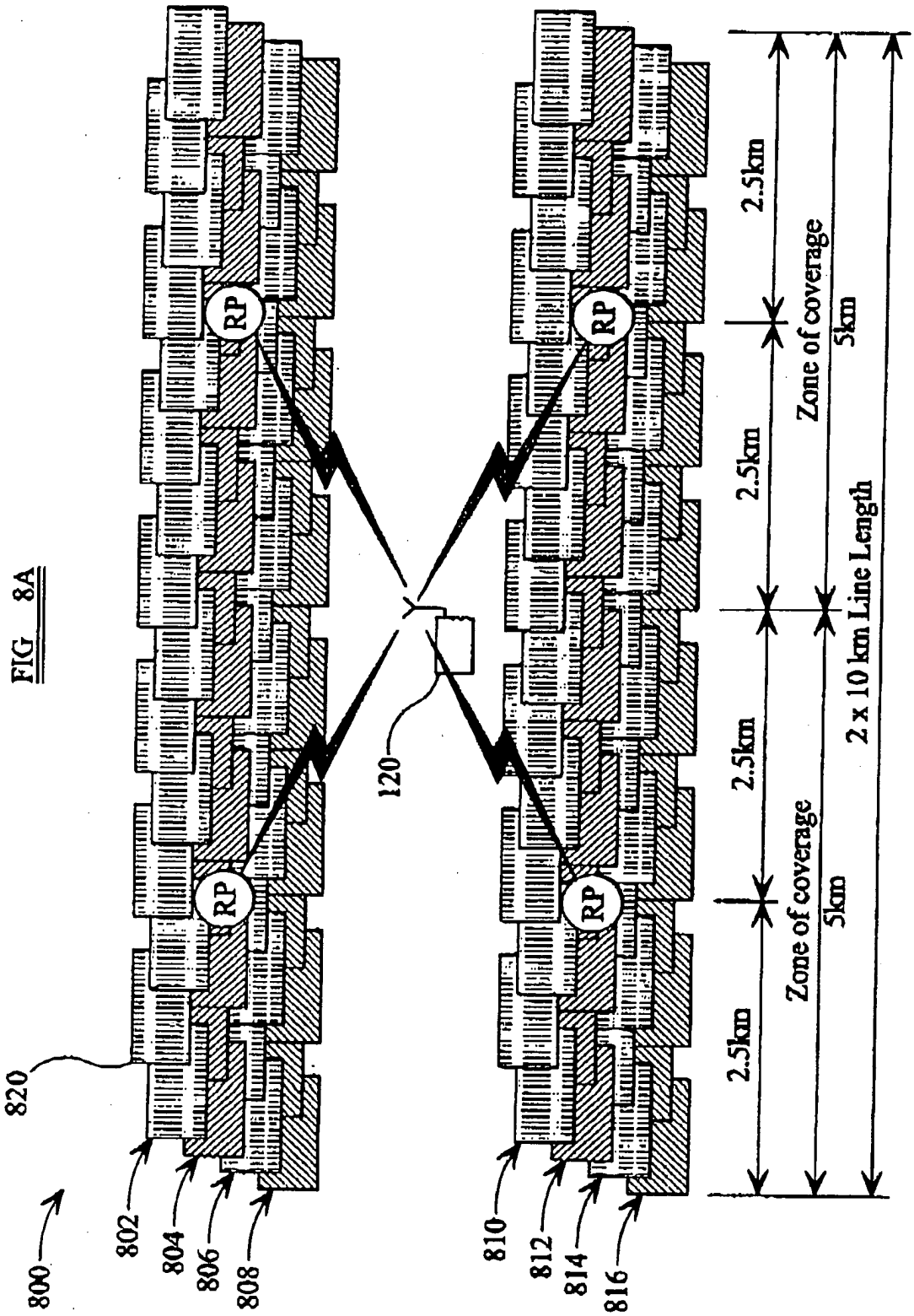
RP
RP
RP
RP
120
800
802
804
806
808
810
812
814
816
820
2.5km
2.5km
2.5km
2.5km
Zone of coverage
5km
Zone of coverage
5km
2 x 10 km Line Length

FIG 8A

11 +2 04

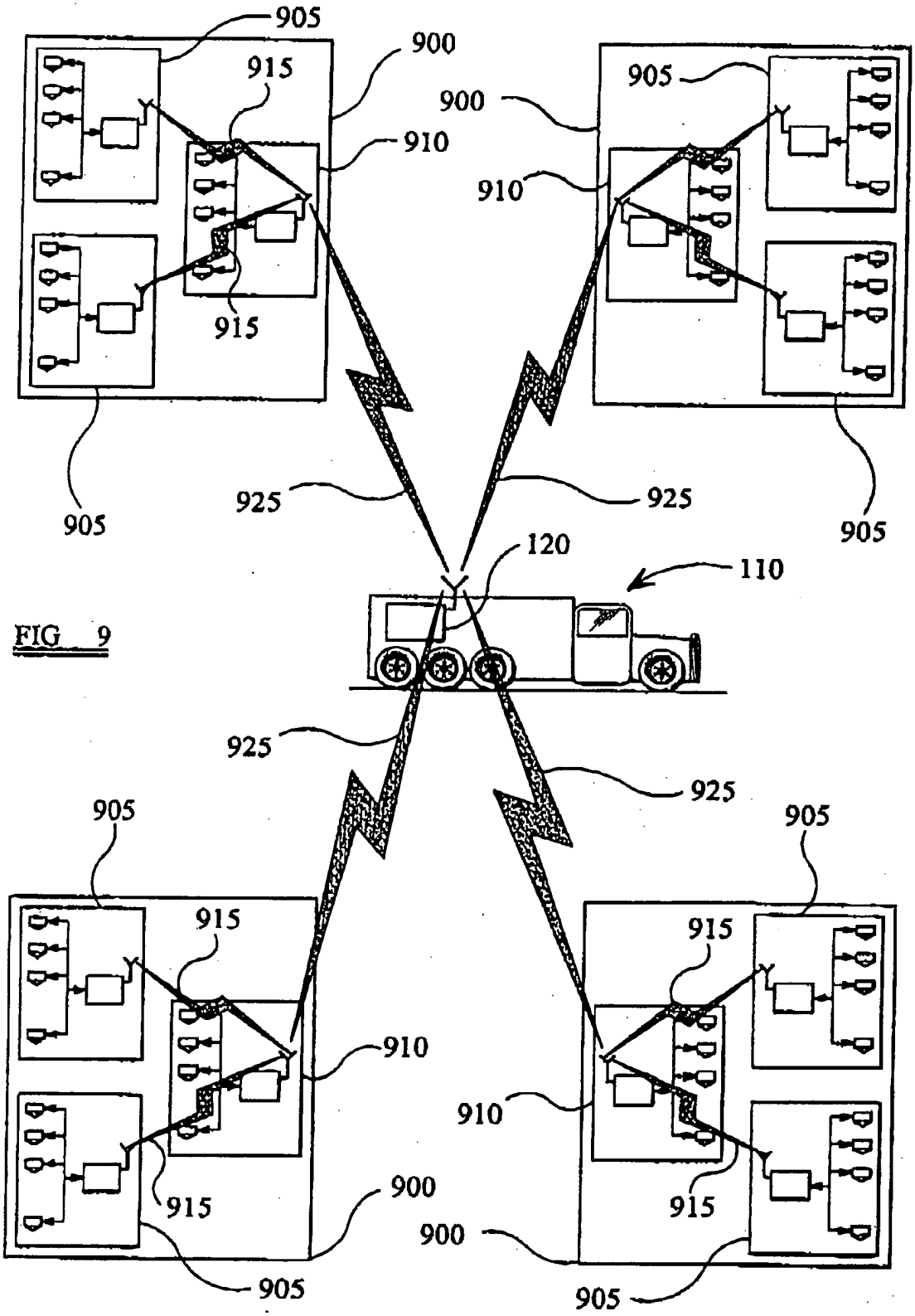
905
915
900
910
905
900
910
915
905
905
925
925
905
120
110
925
925
905
905
915
915
910
910
915
915
900
900
905
905

FIG 9

SEISMIC ACQUISITION SYSTEM

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

The present invention pertains to seismic acquisition, and, more particularly, to a method of collecting data during a seismic acquisition.

2. DESCRIPTION OF THE RELATED ART

Seismic surveying traditionally involves imparting acoustic waves from an acoustic source that propagate through subterranean geological formations and are reflected back to seismic sensors. The seismic sensors are deployed in arrays and are positioned through the area being surveyed. The reflected signals are transformed into electrical or optical signals that are then transmitted over electrical or optical cables to a data collection unit. In a land-based survey, the data collection unit is usually housed on a recording truck. The data collection unit either records the signals it receives, analyzes them in real-time, transmits them to a remote location for analysis, or some combination of these things.

Recent trends in seismic surveying are producing larger arrays of seismic sensors. These arrays are larger both in terms of coverage area and in terms of the number of seismic sensors. The larger arrays adversely impact the cost of conducting the survey. Not only do these larger arrays employ more pieces of equipment, but their extended coverage area lengthen deployment time. The more time it takes to deploy the array, and the more pieces of equipment it uses, the more expensive the survey.

Attempts in the art to address these factors include U.S. Letters Patent 6,226,601, entitled "Seismic Survey System," and issued May 1, 2001, to Trimble Navigation Limited as assignee of the inventor Harold L. Longaker ("the '601 patent"). In particular, this patent discloses a wireless seismic system in an effort to eliminate, or at least minimize, cabling. The system includes multiple layers of "cells." The seismic sensors are grouped in a particular fashion, and each group of seismic sensors wirelessly transmits its data to a dedicated, first level transceiver. The first level transceivers are similarly grouped, and each group of first level transceivers wirelessly transmits the data accumulated from its group of

seismic sensors to a dedicated, second level transceiver. This process repeats, and each higher level sees a further consolidation of data from the previous layer. At some point, the data is completely consolidated or has reached some desired level of consolidation. The consolidated data is then wirelessly transmitted to a data collection unit.

Conventional wireless approaches, such as the one in the '601 patent mentioned above, use a variety of communications protocols. These communications protocols include:

- GSM-DCS, or Global System for Mobile Communications-Digital Cellular System, which employs a form of time-division multiplexing called Time Division Multiple Access ("TDMA"), used for cellular telephony in much of Europe and Asia;
- UMTS, or Universal Mobile Telecommunications System, used to deliver broadband information at speeds up to 2Mbit s/sec, including audio and video, to wireless devices anywhere in the world through fixed, wireless and satellite systems;
- DECT, or Digitally Enhance Cordless Telecommunications, a common standard for cordless personal telephony originally established by the European Telecommunications Standards Institute ("ETSI"), a European standardization body, for cordless business communications;
- CDMA, or Code-Division Multiple Access, a digital cellular technology that uses spread-spectrum techniques; and
- GPRS, or General Packet Radio Service, a standard for wireless communications which runs at speeds up to 115 kilobits per second and supports a wide range of bandwidths.

However, the application of each of these protocols brings its own problems. For instance:

- UMTS, DECT, and CDMA are telephony oriented, rather than network oriented, which imposes undesirable restrictions on communication of data in a seismic acquisition environment;
- UMTS is unproven in terms of its components;
- UMTS and GSM have the same upstream bandwidth as downstream bandwidth, which is wasteful in a seismic acquisition system needing a much higher upstream bandwidth than downstream bandwidth;

GPRS allocates more than one channel downstream and sometimes none upstream, which is contrary to the needs of a seismic acquisition system;

GSM-DSC causes a poor use of the number of channels in the cell versus the possible range of the cell because of a disparity between the density of geophones in the cell and the surface area of the cell; and

GSM-DSC still employs a wire between its base transceiver unit ("BTS") and the Basic Station Controller ("BSC") and between the BSC and the central recording and processing system.

Thus, current wireless techniques applied in seismic acquisition leave much to be desired.

The present invention is directed to resolving, or at least reducing, one or all of the problems mentioned above.

SUMMARY OF THE INVENTION

The invention includes, in its various embodiments and aspects, an apparatus and method for collecting data acquired during a seismic survey.

The apparatus is a seismic survey system, comprising a plurality of data sources, a plurality of cells, and a plurality of independent pathways. The data sources are positioned about an area to be surveyed, each data source being associated with a transmitter capable of transmitting data. The cells each contain a portion of the data sources and their associated transmitters. One of the transmitters within each cell also serves as a gateway for receiving data transmitted from the other data source transmitters within the cell. The independent pathways each contain a portion of the gateways whereby data may be transmitted along each pathway via the or each gateway and associated transmitter in that pathway.

The method is a method for conducting a seismic survey. The method comprises positioning a plurality of seismic data sources about an area to be surveyed, each data source being associated with a transmitter; defining a plurality of cells such that each cell contains a portion of the seismic data sources; defining one of transmitters within each cell to also serve as a gateway; defining a plurality of independent pathways such that each pathway contains a portion of the gateways; within each respective cell, transmitting seismic data from the seismic data sources to the gateway; and, within each pathway, transmitting the seismic data through the portion of the gateways to reach a central location.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention may be understood by reference to the following description taken in conjunction with the accompanying drawings, in which like reference numerals identify like elements, and in which:

FIG. 1 illustrates a land-based seismic survey employing a seismic array constructed, deployed, and operated in accordance with one particular embodiment of the present invention

FIG. 2 conceptually illustrates the seismic array in **FIG. 1**;

FIG. 3 depicts a grouped data acquisition cell from **FIG. 2** in greater detail;

FIG. 4A and **FIG. 4B** illustrate alternative implementations of a basic data acquisition cell such as may comprise the grouped data acquisition cell of **FIG. 3**;

FIG. 5A and **FIG. 5B** conceptually illustrate a data collection unit as may be used in the embodiment of **FIG. 1**;

FIG. 6A, **FIG. 6B**, and **FIG. 6C** illustrate one particular embodiment in which grouped data acquisition cells overlap;

FIG. 7 illustrates a second embodiment alternative to that in **FIG. 6A**, **FIG. 6B**, and **FIG. 6C** in which the grouped data acquisition cells not only overlap, but are interleaved;

FIG. 8A and **FIG. 8B** illustrate a third embodiment alternative to those in **FIG. 6A**, **FIG. 6B**, and **FIG. 6C** and in **FIG. 7** in which relay points are employed between interleaved grouped data acquisition cells and the data collection unit to improve bandwidth; and

FIG. 9 illustrates a fourth embodiment alternative to those in **FIG. 6A**, **FIG. 6B**, and **FIG. 6C**, in **FIG. 7**, and in **FIG. 8A** and **FIG. 8B**.

While the invention is susceptible to various modifications and alternative forms, the drawings illustrate specific embodiments herein described in detail by way of example. It should be understood, however, that the description herein of specific embodiments is not intended to limit the invention to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF THE INVENTION

Illustrative embodiments of the invention are described below. In the interest of clarity, not all features of an actual implementation are described in this specification. It will of course be appreciated that in the development of any such actual embodiment, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort, even if complex and time-consuming, would be a routine undertaking for those of ordinary skill in the art having the benefit of this disclosure.

FIG. 1 illustrates a land-based seismic survey employing a seismic survey system 100 in accordance with the present invention. The apparatus includes a seismic recording array 105 constructed, deployed, and operated as discussed further below. The seismic recording array 105 includes a plurality of data sources 106 positioned about an area to be surveyed, each data source 106 being associated with a transmitter 108 capable of wirelessly transmitting data collected by the data sources 106, as indicated by the wireless link 109. The data sources 106 are implemented, in the illustrated embodiment, with, *e.g.*, conventional geophones as are known to the art.

FIG. 1 shows the seismic recording array 105 connected to the recording truck 110 via the wireless link 109. A seismic source 115 is also shown. A data collection unit 120 is shown centrally located on the recording truck 110. However, as will be appreciated by those skilled in the art, various portions of the data collection unit 120 may be distributed in whole or in part, *e.g.*, across the seismic recording array 105, in alternative embodiments. The seismic source 115 generates a plurality of seismic survey signals 125 in accordance with conventional practice. The seismic survey signals 125 propagate and are reflected by the subterranean geological formation 130. The seismic data sources 120 receive the reflected signals 135 off the geological formation 130 in a conventional manner.

The seismic data sources 106 then generate data representative of the reflections 135, and the seismic data is embedded in electromagnetic signals. The electromagnetic signals are then communicated to the data collection unit 120 in accordance with the present invention. More particularly, the seismic data sources 106 communicate the seismic data they collect to

the data collection unit 120 over the wireless link 109 through the transmitter 108 in a manner discussed more fully below.

The data collection unit 120 collects the seismic data for processing. The data collection unit 120 may process the seismic data itself, store the seismic data for processing at a later time, transmit the seismic data to a remote location for processing, or some combination of these things. In the illustrated embodiment, the data collection unit 120 transmits the seismic data to a fixed-base facility 140 via a satellite 145 and the satellite links 150, although this is not necessary to the practice of the invention. Ultimately, in accordance with the present invention, the data collected by the seismic data sources 106 is transmitted to a central facility or location. This central facility may be a computing and storing center ("CSC"), *e.g.*, the recording truck 110 or the fixed-base facility 140.

FIG. 2 conceptually illustrates the arrangement of the data sources 106 in the seismic recording array 105 in **FIG. 1**. The seismic array 105 comprises a plurality of grouped data acquisition cells ("GDACs") 200. In the illustrated embodiment, there are four, but the invention is not so limited. The number of GDACs 200 will vary by implementation. An individual GDAC 200 is depicted in **FIG. 3**. Each GDAC 200 comprises a plurality of basic data acquisition cells ("BDACs") 300. The number of BDACs 300 in each 200 is not material to the practice of the invention, but three BDACs 300 are shown in the GDAC 200 of **FIG. 3**. Note that the number of BDACs 300 in any given GDAC 200 may vary. For instance, one GDAC 200 may comprise three BDACs 300 while another GDAC 200 in the same array may comprise four BDACs 300.

Each BDAC 300 comprises a plurality of seismic sensors 305 and a central transmission unit 310. The connections between the seismic sensors 305 and the central transmission units 310 may be wired, as in the BDAC 400a in **FIG. 4A**, or wireless, as in the BDAC 400b in **FIG. 4B**. The seismic sensors 305 will typically be acquisition devices, *e.g.*, geophones, but other types of seismic sensors may also be employed. For instance, some of the seismic sensors may be positioning devices, *e.g.*, Global Positioning System ("GPS") receivers. Still other kinds of seismic sensors may also be employed. However, in at least one BDAC 300 of each GDAC 200, the transmitter 315 is also capable of receiving seismic data from the other transmitters 310 and transmitting that seismic data along with its own.

Thus, the seismic recording array 105 includes a plurality of cells, *e.g.*, the GDACs 300. Each cell contains a portion of the data sources 106, *e.g.*, the data sources 305, and their associated transmitters, *e.g.*, the transmitters 310. One of the transmitters within each cell, *e.g.*, the transmitter 315, also serves as a "gateway" for receiving data transmitted from the other data source transmitters, *e.g.*, the transmitters 310, within the cell.

As noted relative to **FIG. 1**, the seismic survey system 100 includes at least one data collection system 120. Note that some alternative embodiments may employ multiple data collection systems 120. The recording truck 105 is equipped with a rack-mounted computing apparatus 500, illustrated in **FIG. 5A** and **FIG. 5B**, with which at least a portion of data collection system 140 is implemented. The computing apparatus 500 includes a processor 505 communicating with some storage 510 over a bus system 515. The storage 510 may include a hard disk and/or random access memory ("RAM") and/or removable storage such as a floppy magnetic disk 517 and an optical disk 520. The storage 510 is encoded with a data structure 525 storing the data set acquired as discussed above, an operating system 530, user interface software 535, and an application 565. The user interface software 535, in conjunction with a display 540, implements a user interface 545. The user interface 545 may include peripheral I/O devices such as a key pad or keyboard 550, a mouse 555, or a joystick 560. The processor 505 runs under the control of the operating system 530, which may be practically any operating system known to the art. The application 565 is invoked by the operating system 530 upon power up, reset, or both, depending on the implementation of the operating system 530.

Referring again to **FIG. 1**, the acoustic waves 125, their reception by seismic sensors 300 (first shown in **FIG. 3**), and the generation of data from the reflections 135 may be performed in conventional fashion. Thus, for instance, the seismic source 115 may be any seismic source known to the art, *e.g.*, a vibrator or an explosive charge. Similarly, the seismic sensors 305 (first shown in **FIG. 3**) may implemented using any type of seismic sensor known to the art and suitable for the survey being implemented.

Data transmission to the data collection unit 120, however, is performed in accordance with the present invention. One BDAC 300 in each GDAC 200 is a "gateway" to

the GDAC 200. All communications to and from any BDAC 300 in the GDAC 200 to and from the central location mentioned above (*e.g.*, the data collection unit 120) proceeds through the gateway BDAC 300. It is not material to the practice of the invention which particular BDAC 300 is designated the gateway, although range and power considerations in any given implementation may influence the designation.

Referring now again to **FIG. 2**, each BDAC 205 that is not a gateway 210 transmits its data via its central transmitting unit 310 (first shown in **FIG. 3**) to the gateway 210 of its GDAC 200, as represented by the wireless links 215. The gateway 210 collects the data from the other BDACs 205 and wirelessly transmits the accumulated data to the next GDAC 200 in the direction of the data collection unit 120, as represented by the wireless links 220. If there is no such GDAC 200, then the data is wirelessly transmitted directly to the recording unit 120, as represented by the wireless link 225. Thus, seismic data is transmitted in this "cascaded" fashion across the seismic recording array 105 and, ultimately to a CSC. Note that the any given GDAC 200 receives data transmitted by only one other GDAC 200. Thus, the wireless links 220, 225 represent a plurality of independent pathways, each containing a portion of the gateways whereby data may be transmitted along each pathway via the gateways and associated transmitters in that pathway. In some embodiments, information can also be transmitted to the BDACs 205 and gateways 210 back over these same pathways.

Data can be transmitted between GDACs 200 in one of at least two ways. First, data may be transmitted in a continuous, or asynchronous, mode. In this mode, gateway 210_i transmits to gateway 210_{i+1} when data is ready for transmission, without regard for when gateway 210_{i+1} transmits data to 210_{i+2}. In this fashion, each gateway 210 receives data transmitted to it, assembles it with its own data, and transmits the resultant data set to the next gateway 210 in the pathway until the data reaches the data collection unit 120. Second, data may be transmitted in a discontinuous, or synchronous, mode. In this mode, data is transferred from gateway 210_i to gateway 210_{i+1} at the same time gateway 210_{i+2} transmits data to 210_{i+3} and at predefined periods. In the next predefined period, data is transferred from gateway 210_{i+1} to gateway 210_{i+2} at the same time gateway 210_{i+3} transmits data Thus, at a predetermined time half of the gateways 210 transmit what data it has to the next gateway 210 in the pathway and, at the next predetermined time, the second half transmits its data to the next gateway 210..

In the illustrated embodiment, the data is transmitted over the wireless links 220, 225 using the 802.11 standard. The 802.11 standard is a family of specifications developed by the Institute of Electrical and Electronics Engineers ("IEEE") for wireless local area network ("LAN") technology. 802.11 specifies an over-the-air interface between a wireless client and a base station or between two wireless clients. There are several specifications in the 802.11 standard, including:

- 802.11—applies to wireless LANs and provides 1 or 2 Mbps transmission in the 2.4 GHz band using either frequency hopping spread spectrum ("FHSS") or direct sequence spread spectrum ("DSSS").
- 802.11a—an extension to 802.11 that applies to wireless LANs and provides up to 54 Mbps in the 5GHz band. 802.11a uses an orthogonal frequency division multiplexing encoding scheme rather than FHSS or DSSS.
- 802.11b (also referred to as "802.11 High Rate" or "Wi-Fi")—an extension to 802.11 that applies to wireless LANS and provides 11 Mbps transmission (with a fallback to 5.5, 2 and 1 Mbps) in the 2.4 GHz band. 802.11b uses only DSSS.
- 802.11g—which applies to wireless LANs and provides 20+ Mbps in the 2.4 GHz band.

Other standards, however, may be used in alternative embodiments. However, in various implementations, the communications over the wireless links 22, 225 may employ either frequency division or time division multiplexing techniques.

In the embodiment illustrated in **FIG. 2**, neither the BDACs 205, 210 nor the GDACs 200 overlap. However, this is not necessary to the practice of the invention. Indeed, where increased transmission bandwidth is desired, two or more GDACs 200 may overlap. Consider the embodiment 600 in **FIG. 6A**. In **FIG. 6A**, each GDAC 605 comprises a gateway BDAC 610 (only one indicated) and multiple BDACs 615 (only one indicated) that do not serve as gateways. The GDACs 605 overlap, and the overlap defines a length L for the GDACs 605 different from their coverage range R. Note that the overlaps vary and, consequently, $L_{i-1} \neq L_i \neq L_{i+1}$. Note also that the coverage range R is less than the maximum coverage range R_{max}, *i.e.*, $R_i < R_{imax}$. One consequence of the difference between the actual range R and the maximum range R_{max} is a "secure overlap." The overlap is secure in the

sense that it provides a spatial margin for error in data transmission. **FIG. 6B** illustrates communications between the BDACs 615 and the gateway BDAC 610 in each GDAC 605. **FIG. 6C** illustrates communications between the GDACS 605.

Note that these physical characteristics can impact operational performance. For instance, Table 1 illustrates how the GDAC length *L* impacts bit rates under two different 802.11 standard specifications.

Table 1. GDAC Length *L* *vs.* Bit Rates

	750 m	500 m	250 m	150 m	60 m	50 m	35 m	25 m
In door (54 Mbps)	X	X	X	X	5 Mbps	10 Mbps	35 Mbps	54 Mbps
In door (11 Mbps)	X	X	X	X	1 Mbps	2 Mbps	5.5 Mbps	11 Mbps
Out door (54 Mbps)	X	X	X	X	X	X	X	X
Out door (11 Mbps)	1 Mbps	2 Mbps	5.5 Mbps	11 Mbps	11 Mbps	11Mbps	11 Mbps	11 Mbps

Those skilled in the art having the benefit of this disclosure will also appreciate other ways in which the physical characteristics of the GDACs affect operational performance. For instance, the distance between the gateways 610 may be limited to meet transmission licensing constraints and/or to improve reliability. Note that the characteristics presented in Table might change over time due to improvements in the seismic survey system and/or protocols employed.

Other variations may also be employed. GDACs may, for instance, also be interleaved, and communications may be conducted using more than one carrier frequency. Consider the embodiment 700 in **FIG. 7**, in which the GDACs 705 are interleaved and in which the GDACS 705 communicating on different carrier frequencies are indicated in different hatch patterns. Thus, the "top" line 710 communicates on a first carrier frequency

and the "bottom" line 715 communicates on a second frequency. Each of the lines 710, 715 communicates in the manner illustrated by **FIG. 6A** -- **FIG. 6C**, with communications within GDACs 705 conducted as shown in **FIG. 6B** and communications between GDACs 705 conducted as shown in **FIG. 6C**. Eventually, the data communicated through the top line 710 and through the bottom line 715 is transmitted to the CSC, *e.g.*, the recording truck 110 or the fixed-base facility 140 in **FIG. 1**. Note, however, that communications through the top line 710 on the first carrier frequency constitute a separate, independent pathway to the CSC relative to the communications through the bottom line 715.

In larger spreads, bandwidth can be increased by the use of "relay points" on the independent pathways. **FIG. 8A** illustrates one such embodiment 800, which is a 10 km long spread, divided into two 5 km long "zones of coverage." Each zone of coverage is separated into 2.5 km areas. Each relay point RP is positioned, in this particular embodiment, to roughly divides the 5 km zone of coverage into the 2.5 km areas. Note that the distances are not material to the practice of the invention. Similarly, the relay points RP need not necessarily divide the zone of coverage in half in all implementations of this embodiment.

The relay points RP act as wireless bridges between the data acquisition and the data collection. In the illustrated embodiment, they are implemented using Cisco Aironet 340 Series Wireless Bridges commercially available "off the shelf" from Cisco Systems, Inc., 170 West Tasman Dr., San Jose, California 95134, U.S.A. Information about these bridges is readily available at this address, by phone at (800) 553-NETS, or over the World Wide Web at www.cisco.com. However, the invention is not so limited and any suitable electronic device may be used.

Still referring to **FIG. 8A**, the spread comprises 8 "lines" 802 -- 816 of GDACs 820 (only one indicated). Each line 802 – 816 operates on one of four carrier frequencies indicated by four different hatching patterns. Thus, lines 802, 810 operate on a first carrier frequency; lines 804, 812 operate on a second carrier frequency; lines 806, 814 operate on a third carrier frequency; and lines 808, 816 operate on a fourth carrier frequency.

In operation, the GDACs 820 transmit their data in the asynchronous mode discussed above, as shown in **FIG. 8B**. As the gateway 310_0 gathers data collected in the GDAC 820_0,

it transmits it to the gateway 310_1. The gateways 310_1, 310_2 act similarly with respect to data collected from the its respective $GDAC_1$, $GDAC_2$ and preceding GDAC 820_0, 820_1, respectively. Data is handled in the same manner by the gateways 310_6, 310_7. However, the data does not continue to cascade across all GDACs 820 in the lines 802 – 816. Instead, the gateways 310_3, 310_4 transmit data collected by their $GDAC_3$, $GDAC_4$ and the preceding GDACs in its independent pathway to the relay point RP, which relays the data to the data collection unit 120.

Returning now to **FIG. 8A**, each relay point RP serves one 5 km zone of coverage for one set of lines 802 – 808, 810 - 816. Thus, in the illustrated embodiment, each line 802 – 816 includes two gateways 310_3, 310_4, as shown in **FIG. 8B**, that transmit to a relay point RP, which then relays the data to the data collection unit 120. In one particular implementation, the invention achieved performance as good as or better than conventional wired acquisition systems. This performance included a bandwidth of 144 kbps x N, where N is the number of sensors (up to 100,000 "1D" or "3D" geophones); real time data acquisition and transmission to a central system for computing and storing, and a range of 10 km x 5 km for the spread. Table 2 presents some operational parameters for an implementation such as that in **FIG. 8A**, **FIG. 8B**, assuming 11 Mbps and two relay points with an 802.11 protocol.

Table 2. Operational Parameters

Compression	"1D" Geophone	"3D" Geophone
None	20m ≤ BDAC ≤ 50m cell ≤ 250m	BDAC = 50m cell ≤ 250m
Compression factor = 2	10m ≤ BDAC ≤ 50m cell ≤ 250m	30m ≤ BDAC ≤ 50m cell ≤ 250m

Note that the practice of the invention does not require that the data be transmitted from one GDAC to another in the "cascaded" fashion shown in the embodiments discussed above. In sufficiently small spreads, such as the one shown in **FIG. 9**, comprising only a few GDACs 900, the BDACs 905 transmit the data they collect to the gateway BDAC 910 as was discussed above. However, the gateway BDACs 910 transmit their data and the data received from the other BDACs 905 directly to the data collection unit 120, rather than through other

GDACs 900. Thus, the wireless links 925 constitute the independent pathways in such an embodiment.

Note also that, in the illustrated embodiments, all the communications pathways are shown as substantially linear, the cells are shown have rectangular geometries, and the cells are arranged in "lines" running left to right. However, these conventions are employed for ease and clarity in illustration, and the invention is not limited in these respects. The cells may employ other geometries, and the communications pathways may be substantially non-linear in alternative embodiments. Also, the left to right orientation of the lines in the illustrated embodiments is a convenience for clarity in illustration. The invention admits wide variation in these aspects.

The particular embodiments disclosed above are illustrative only, as the invention may be modified and practiced in different but equivalent manners apparent to those skilled in the art having the benefit of the teachings herein. Furthermore, no limitations are intended to the details of construction or design herein shown, other than as described in the claims below. It is therefore evident that the particular embodiments disclosed above may be altered or modified and all such variations are considered within the scope and spirit of the invention. Accordingly, the protection sought herein is as set forth in the claims below.

Claims

1. A seismic survey system (100), comprising:

a plurality of data sources (106) positioned about an area to be surveyed, each data source (106) being associated with a transmitter (108) capable of transmitting data;

a plurality of cells (200) each containing a portion of the data sources (106) and their associated transmitters (108), one of the transmitters (108) within each cell (200) also serving as a gateway (315) for receiving data transmitted from the other data source (106) transmitters (108) within the cell (200); and

a plurality of independent pathways (225), each independent pathway containing at least one gateway (315) whereby data may be transmitted along each pathway (225) via the at least one gateway (315) in that pathway (225).

2. The seismic survey system (100) of claim 1, wherein no gateway in a path directly receives data from more than one gateway or directly transmits data to more than one gateway.

3. The seismic survey system (100) of claim 1, wherein at least one cell (200) is arranged to, in addition to transmitting data from data sources in the cell, relay, in use, data received from a gateway (315) of another cell.

4. The seismic survey system (100) of claim 1, further wherein the transmitter (108) capable of transmitting data comprises a transmitter (108) capable of wirelessly transmitting data.

5. The seismic survey system (100) of claim 1, further comprising a computing and storing center (110, 140) for receiving the data transmitted along each pathway (225).

6. The seismic survey system (100) of claim 5, further comprising at least a pair of relay points (RP) through which the data transmitted along each independent pathway (225) is relayed to the computing and storing center (110, 140).

7. The seismic survey system (100) of claim 1, further comprising a fixed-base facility (140) to which the data is transmitted.

8. The seismic survey system (100) of claim 7, further comprising a recording truck (110) through which the data is transmitted to the fixed-base facility (140).

9. The seismic survey system (100) of claim 1, wherein the transmitters (108) capable of transmitting data are capable of transmitting data in an asynchronous mode.

10. The seismic survey system (100) of claim 1, wherein the transmitters (108) capable of transmitting data are capable of transmitting data in a synchronous mode.

11. The seismic survey system (100) of claim 1, wherein the data is transmitted along each independent pathway (225) according to frequency division multiplexing.

12. The seismic survey system (100) of claim 1, wherein the data is transmitted along each pathway (225) according to time division multiplexing.

13. The seismic survey system (100) of claim 1, wherein the distance between gateways (315) of adjacent cells (200) is limited according to transmission licensing constraints.

14. The seismic survey system (100) of claim 1, wherein the distance between gateways (315) of adjacent cells (200) is limited to improve reliability.

15. The seismic survey system (100) of claim 1, wherein the pathways (225) are substantially linear.

16. The seismic survey system (100) of claim 1, wherein the cells (200) overlap.

17. The seismic survey system (100) of claim 1, wherein the cells (200) are interleaved.

18. A method for use in seismic surveying, comprising:

collecting a plurality of seismic data at a plurality of seismic data sources (106), , each data source (106) being associated with a transmitter (108) capable of transmitting data, the seismic data sources (106) being organized into a plurality of cells (200), one of the transmitters (108) within each cell (200) also serving as a gateway (315) for receiving data transmitted from the other data source (106) transmitters (108) within the cell (200);

transmitting the collected seismic data over a plurality of independent pathways (225) to a central location (110), each independent pathway containing at least one gateway (315) whereby data may be transmitted along each pathway (225) via the at least one gateway; and

collecting the transmitted seismic data at the central location (110).

19. The method of claim 18, wherein no gateway in a path directly receives data from more than one gateway or directly transmits data to more than one gateway.

20. The method of claim 18, wherein transmitting the collected seismic data includes transmitting the collected seismic data using one of frequency division multiplexing and time division multiplexing.

21. The method of claim 18, wherein the cell (200) definitions are constrained with transmission licensing constraints.

22. The method of claim 18, wherein the distance between cells (200) is constrained to improve reliability.

23. The method of claim 18, wherein the cells (200) overlap.

24. The method of claim 18, wherein the cells (200) are interleaved.

25. The method of claim 18, wherein defining the independent pathways (225) include at least a pair of relay points (RP) through which the collected seismic data is transmitted to the central location (110).

[redacted] Remote User

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Your Reference: AMS.P52428GB
Application No: GB 0227293.8

6 May 2003

Dear Sirs

Patents Act 1977: Search Report under Section 17(5)

I enclose two copies of my search report and a copy of the citations.

Publication

I estimate that, provided you have met all formal requirements, preparations for publication of your application will be completed soon after **13 April 2004**. You will then receive a letter informing you of completion and telling you the publication number and date of publication.

Amendment/withdrawal

If you wish to file amended claims for inclusion with the published application, or to withdraw the application to prevent publication, you must do so before the preparations for publication are completed. **No reminder will be issued.** If you write to the Office less than 3 weeks before the above completion date, please mark your letter prominently: **"URGENT - PUBLICATION IMMINENT".**

Yours faithfully

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[1]**Use of E-mail:** Please note that e-mail should be used for correspondence only.

Application No: GB 0227293.8 **Examiner:** Anita Keogh
Claims searched: 1-44 **Date of search:** 2 May 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance	
X	1-3, 5-6, 9-10, 13, 16-18, 20-21, 24-25, 28, 31-32, 38-39 at least	US 6226601 B1	(LONGAKER) see whole document, especially column 5 lines 51-53 and column 6 lines 53-55
X	38, 42	WO 98/18022 A1	(VIBRATION TECHNOLOGY) see whole document
X	38	US 5706250	(RIALAN et al.) see abstract and figures 1 & 4
X	38, 42	WO 98/07049 A2	(PETROLEUM GEO-SERVICES) see figures
X	38	US 5627798	(SIEMS et al.) see figure 1

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
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&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[V]:

G4H, H4L

Worldwide search of patent documents classified in the following areas of the IPC[7]:

G01V, G08C, H04B, H04L, H04Q

The following online and other databases have been used in the preparation of this search report:

Online: WPI, JAPIO, EPODOC

US006226601B1

(12) **United States Patent**
Longaker

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(45) **Date of Patent: *May 1, 2001**

(54) **SEISMIC SURVEY SYSTEM**

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(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days

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Primary Examiner—Kamini Shah
(74) *Attorney, Agent, or Firm*—Blakely, Sokoloff, Taylor & Zafman LLP

(57) **ABSTRACT**

A wireless seismic survey system is structured as a hierarchy of cell network layers, each higher level cell network layer covering a bigger area than a lower level cell network layer and receiving data from the lower level cell network layer. This hierarchical structure functions to concentrate collected data to a level that can be communicated to a central collection point, either through wireless, cable or other media. By defining cells to cover predetermined areas, transmission frequencies and/or transmission time slots or codes can be reused by cells sufficiently spaced apart to avoid co-channel interference, thereby increasing the amount of usable bandwidth.

20 Claims, 10 Drawing Sheets

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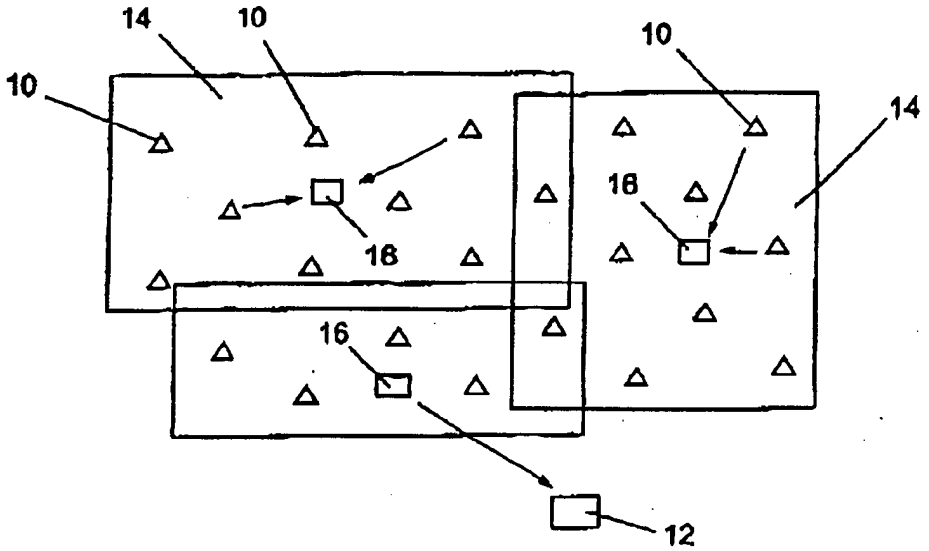

(57) Abstract

A seismic acquisition system divides a survey terrain into a number of cells (14) each containing a cell access node (16) and a number of geophone units (10). The geophone units (10) transmit data in digital form to the respective cell access node (16) by wireless telemetry, and the cell access nodes (16) forward the data to a central control (12) by broadband channels.

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United States Patent [19]

Rialan et al.

[11] Patent Number: 5,706,250

[45] Date of Patent: Jan. 6, 1998

[54] SEISMIC TRANSMISSION METHOD AND SYSTEM UTILIZING CONCENTRATION UNITS

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Oct 12, 1992 [FR] France 92 12328

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[52] U.S. Cl. 367/77; 367/80; 340/825.15

[58] Field of Search 367/77, 80; 340/825.15

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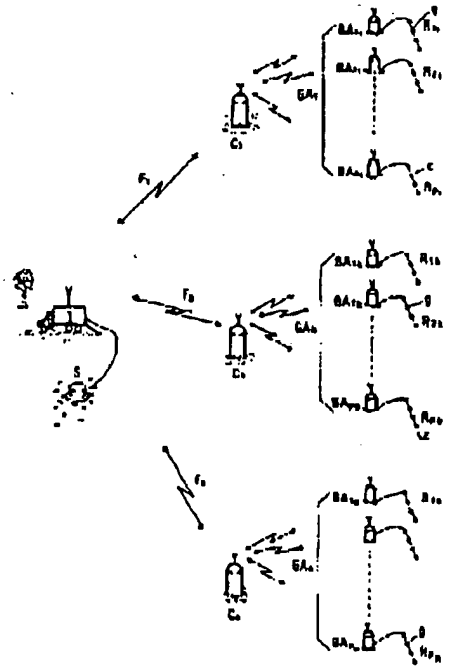
Attorney, Agent, or Firm—Antonelli, Terry, Stout & Kraus, LLP

[57] ABSTRACT

Seismic data acquisition devices (BA) distributed in an exploration zone are divided into n groups (GA1 to GAn) and, therein, into sub-groups having each a specific frequency for communicating with a concentration unit (Ck) which is connected to a central station (1) through Hertzian channels or cables or optical fibers. Acquisition devices in the various subgroups communicate simultaneously with the corresponding concentration unit (Ck) during predetermined emission windows. The concentration unit collects the signals received from the acquisition devices to transmit them in series to station (1). The acquisition devices are adapted for delaying their own emission window according to the rank which has been previously assigned thereto within the respective subgroups thereof.

19 Claims, 4 Drawing Sheets



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Published
Without international search report and to be republished upon receipt of that report.

(54) Title: RESERVOIR ACQUISITION SYSTEM WITH CONCENTRATOR

(57) Abstract

A process comprising: transmitting remote data signals independently from each node of the plurality of permanently coupled remote sensor nodes to a concentrator of the data signals, and transmitting concentrated data signals from the concentrator to a recorder. A reservoir monitoring system comprising: a plurality of permanently coupled remote sensor nodes; a concentrator of signals from the plurality of permanently coupled remote sensor nodes; and a recorder of concentrated signals from the concentrator. A reservoir monitoring system comprising: a plurality of permanently coupled remote sensor nodes, wherein each node comprises a plurality of seismic sensors and a digitizer of analog signals; a concentrator of signals received from the plurality of permanently coupled remote sensor nodes; a plurality of remote transmission lines which independently connect each of the plurality of remote sensor nodes to the concentrator; a recorder of concentrated signals from the concentrator; and a transmission line which connects the concentrator to the recorder

US005627798A

United States Patent [19]

Siems et al.

[11] Patent Number: 5,627,798

[45] Date of Patent: May 6, 1997

[54] HIERARCHICAL TELEMETRY SYSTEM FOR SEISMIC ACQUISITION

[75] Inventors: Lee E. Siems, Sinonton, Gary L. Scott, Sugar Land, both of Tex.

[73] Assignee: I/O Exploration Products (U.S.A.), Inc., Stafford, Tex.

[21] Appl. No.: 435,889

[22] Filed: May 5, 1995

[51] Int. Cl.[6] G01V 1/22

[52] U.S. Cl. 367/76; 340/825.15

[58] Field of Search 367/21, 20, 76, 367/18, 79, 80; 340/825.15

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Primary Examiner—Ian J. Lobo

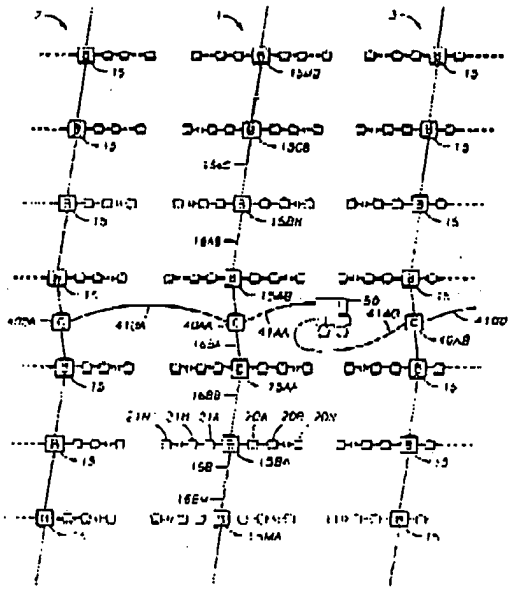
Attorney, Agent, or Firm—Haynes and Boone, L.L.P.; Tim Headley

[57] ABSTRACT

The invention is a seismic acquisition system for communicating seismic sensor signals to a recording unit, including a control unit and analog-to-digital conveyer units connected to the control unit. The conveyer units each include integral interconnecting cables having an hermaphroditic connector at each end, analog seismic sensor inputs and signal processing circuitry disposed within a watertight housing forming part of the cables. The circuitry includes analog-to-digital conveyers connected to the analog inputs, a buffer for digitized signals transmitted to one conveyer unit from other conveyer units interconnected to the conveyer unit opposite to the control unit connection, a digital transceiver for retransmission of digitized sensor signals and the buffered signals at a first data rate to the control unit. The control unit includes a second buffer for signals from the conveyer unit and for signals retransmitted from other control units serially codected to the control unit. The control unit further includes a second transceiver for retransmitting buffered signals from the conveyer units and from other control units to the recording unit at a second data rate higher than the first data rate.

A preferred embodiment includes a data buffering unit interconnected between the recording unit and the control unit. The buffering unit comprises another digital transceiver for communicating control signals from the recording unit and sending digited signals to the recording unit, and a buffer for storing digitized signals from the control unit and from other ones of the buffering units interconnected to the one buffering unit.

18 Claims, 8 Drawing Sheets



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Your Reference: AMS.P52428GB
Application No: GB0227293.8

28 October 2005

Dear Sirs

Patents Act 1977: Examination Report under Section 18(3)

Latest date for reply: **28 February 2006**

I enclose two copies of my examination report.

By the above date you should either file amendments to meet the objections in the enclosed report or make observations on them. If you do not, the application may be refused.

Yours faithfully

Anita Keogh
Examiner

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[1]Use of E-mail: Please note that e-mail should be used for correspondence only.

Your ref :	AMS.P52428GB	**Examiner :**	Anita Keogh
Application No:	GB0227293.8	**Tel :**	01633 814380
Applicant :	WesternGeco Seismic Holdings Limited	**Date of report :**	28 October 2005
Latest date for reply:	28 February 2006	Page 1/3	

Patents Act 1977
Examination Report under Section 18(3)

Scope, clarity

1. The four independent claims do not define the invention clearly. The two independent system claims (1 and 16) and the two independent method claims (31 and 38) provide different, overlapping definitions of the invention which make it difficult to determine the true scope of the matter for which protection is sought. Thus the claims do not define the invention in a clear and concise manner and amendment is needed. When amending, please bear in mind that as indicated in our "Code of Practice for patent applicants and agents", unless it is unavoidable, the claims should contain no more than one independent claim for each category of invention, which, in this case, would be one system claim and one method claim.

2. In addition, none of the four independent claims individually provide a clear definition of the invention and in all it is necessary to clarify the definition of: the cell arrangement, the gateways and the independent pathways.

3. First, it is unclear whether or not is it essential that each of the plurality of cells contains a "plurality" of data sources (c.16) or whether each cell merely needs to contain "a portion" of the plurality of data sources (c.1, c.31), where "a portion" could be anything from "one" to "all but one" of the plurality of data sources.

4. Second, claims 1 and 31 refer to a cell containing "a portion" of the data sources but it is unclear whether this means that each cell contains "a different portion" of the data sources, implying that, from a functional point of view, a data source resides in only one cell at a time, or whether a data source can functionally reside in two or more overlapping or interleaved cells at the same time. In the invention as described, it seems to me that at any one time, a data source is only ever a member of one cell, even if the coverage areas of the cells overlap or interleave. If my interpretation is correct, the claims should clarify that each cell contains "a different portion" of the data sources and that the cells areas overlap or interleave.

5. Third, the function of the gateway and the arrangement of the gateway apparatus is not clearly defined. Claim 1 indicates that each data source has an associated transmitter and that in each cell, one of these transmitters serves as a gateway. This is in agreement with the described invention as I understand it. In contrast: claim 16 does not indicate that each cell has a gateway; claims 16 and 31 indicate that a data source serves as a gateway, rather than a data source transmitter; and in claim 38, the gateway is neither identified as a data source nor as a data source transmitter.

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Date of report: 28 October 2005
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[Examination Report contd.]

6. Moreover with regard to the gateway, it seems to me that an essential aspect of the gateway is that, in addition to receiving data transmitted from the other data source transmitters within a cell, the gateway is also able to receive data transmitted from one other gateway, see page 8 lines 14-15 and page 12 line 23 – page 13 line 2, and the claims should be clarified accordingly. Claims which require one gateway to transmit data to another gateway (cls. 31 and 38), exclude the embodiment of figure 9.

7. Fourth, the claims are unclear in their definition of the data pathways. From the description it seems that data is transmitted from each data source to a central location along an independent pathway that contains at least one gateway.

8. In my view, claim 1 seems to be the claim that is clearest and most consistent with the described invention and in my opinion, this claim should form the basis for the amended independent claims (system and method). Thus, in summary, it seems to me that:

a) claim 1 line 5 should be amended to indicate that each cell contains "a different portion" of the data sources,
b) claim 1 line 7 should indicate that in addition to receiving data transmitted from the other data source transmitters within the cell, the gateway is also able to receive data transmitted from one other gateway, and
c) claim 1 lines 8-10 should indicate that in the system, "data is transmitted from each data source data to a central location along an independent pathway that contains at least one gateway".

9. A corresponding method claim is also required and consequential amendments may be needed in the dependent claims. In particular, the embodiments employing relays are unclear and require clarification.

Novelty or Inventive step

10. Although your invention is not set out clearly, it seems that it might not be new or that it might be obvious in view of what is disclosed in the following documents:

a) US 6226601 B1 (LONGAKER) - see whole document, especially column 5 lines 51-53 and column 6 lines 53-55
b) WO 98/18022 A1 (VIBRATION TECHNOLOGY) - see whole document
c) US 5706250 (RIALAN et al.) - see abstract and figures 1 & 4
d) WO 98/07049 A2 (PETROLEUM GEO-SERVICES) - see figures
e) US 5627798 (SIEMS et al.) - see figure 1

11. Please note that these documents are the most relevant of many that were found to satisfy the common subject matter of the independent claims, namely "seismic surveying means comprising a plurality of data sources disposed within a plurality of cells where at least

[Examination Report contd.]

one of the cells has at least one gateway to receive data transmitted from the data sources within the cell".

12. Claims 1-3, 5-6, 9-10, 13, 16-18, 20-21, 24-25, 28, 31-32, 38-39 at least, appear to be met by the admitted prior art US6226601. In US'601, one measurement device in each cell acts as a hub that receives data from the other measurement devices in the cell. One of these hubs then acts as a hub for the other hubs and so on.

13. Disclosures in WO 98/18022, US 5706250, WO 98/07049 & US 5627798 further anticipate claims 38 and 42:

a) WO 98/18022 & US 5706250 show seismic data sources arranged in cells, each having a device (not a seismic data source) which wirelessly receives data from the data sources for onward transmission to a central device. In US'250 the transmission may be wireless and/or wired and in the wired arrangement, adjacent concentration units may be coupled to each other, see fig 4. Overlapping cells are shown in WO '022.

b) WO 98/07049 & US 5627798 show wired seismic surveying systems and again, cell overlap is shown in WO '049.

14. You should consider these documents carefully when amending your specification.

Top up/further search

15. Please note that the top up of the original search is being deferred until the true scope of the invention is clarified.

Conflict with a corresponding European patent application

16. This application appears to be similar to your European patent application published under number EP 1573365, having the same priority date and designating GB. If patents granted on these two applications relate to the same invention, the Comptroller will in due course revoke the patent granted on the present application unless **either** you amend the present specification to remove the conflict **or**, before the date of grant of the present application under Section 25(1), you begin proceedings to surrender the European patent (UK). Of course if the GB designation is withdrawn before the grant of the European patent, no action will be required under Section 73(2).

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Your Reference: AMS.P52428GB
Application No: GB0227293.8

15 February 2007

Dear Sirs

Patents Act 1977: Examination Report under Section 18(3)

Latest date for reply: **5 April 2007**

I have re-examined your application in response to your agent's letter of 21 July 2006 and enclose two copies of my further examination report and a copy of the new citations. Please accept my apologies for the delay in this report.

By the above date you should either file amendments to meet the objections in the enclosed report or make observations on them. If you do not, the application may be refused.

You should also note that the normal, unextended period allowed for complying fully with the requirements of the Act will end on **22 May 2007**. However, if you need extra time to settle any remaining objections you are entitled to extend that period by two months by filing Patents Form 52/77 and fee.

Yours faithfully

Anita Keogh
Examiner

[1]**Use of E-mail:** Please note that e-mail should be used for correspondence only.

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Your ref :	AMS.P52428GB	**Examiner :**	Anita Keogh
Application No:	GB0227293.8	**Tel :**	01633 814380
Applicant :	WesternGeco Seismic Holdings Limited	**Date of report :**	15 February 2007
Latest date for reply:	5 April 2007	Page 1/6	

Patents Act 1977
Examination Report under Section 18(3)

Basis of the examination

1. My examination has taken account of the amendments filed with your agent's letter of 21 July 2006. The results of further searching have also been taken into account and there are two new citations, JP 10031075 & US 3886494.

2. As detailed in this report, even though your claims do not define your disclosed invention in a clear or concise manner, it seems that the invention is not novel or inventive since the cited documents anticipate some embodiments and show that the others are not inventive.

Scope, conciseness, clarity,

3. Your claims fail to define the invention in a clear, concise or consistent manner and the application fails to clearly identify the essential elements of the invention.

4. The application contains 44 claims, of which 4 are independent and I maintain my previous objection (see report dated 28 October 2005, paragraph 1) that the different and overlapping definitions provided by the four independent claims (1, 16, 31 & 38) obscure the scope of the invention. The claims as a whole hinder the reader.

5. The guidance provided in our 'Code of Practice for patent applicants and agents' indicates that, unless unavoidable, the claims should contain no more than one independent claim for each category of invention. In certain, limited circumstances, an invention may be such that it is not appropriate to limit the independent claims in this fashion but your invention does not appear satisfy those limited circumstances and it seems that a clear and concise definition of the invention is possible via one system claim and one consistent method claim. (I note that a similar objection regarding multiple independent claims on the equivalent EP 1573365 has resulted in amendment to limit the independent claims to one system claim and one method claim, although, in my opinion, the actual content of those claims (i.e. original claims 1 & 38) is neither clear nor consistent).

6. I have also carefully considered the comments in your letter but respectfully disagree with the argument that each independent claim is clear. In my opinion, none of the claims provide a clear definition of the cell content or 'independent' pathways. However rather than address the various problems of each claim individually, I feel that at this stage it is more expedient for me to state what I understand the disclosed invention to be and what I would

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[Examination Report contd.]

consider a clear definition of that invention. It is hoped that the clarity problems of each independent claim will become apparent from this report as a whole.

7. After careful consideration it seems to me that if one is to make sense of the disclosed arrangement, the system claim should be amended to define:

- the cells in terms of their transmitter (and associated data source) content and gateway content
- the 'independent' pathways, in terms of where the pathway starts and finishes, the gateway content of the pathway and the form of data transmission in the pathway.

8. As a rough guide only, it seems to me that the disclosed invention relates to a seismic survey system comprising a data collection point and a plurality of data sources positioned about an area to be surveyed. Each data source is associated with one wireless transmitter (i.e. the data source(s)-to-transmitter association might be point-to-point or multipoint-to-point but is not point –to-multipoint). The transmitter is for receiving data from its associated data source(s) (either wirelessly or via wires) and for wirelessly transmitting the received data on towards the data collection point. The area to be surveyed is covered by a plurality of cells, where each cell contains at least three of these wireless transmitters and their associated data sources.

- Please note that I have referred to 'at least three transmitters' rather than 'at least two transmitters' because this corresponds to the described and illustrated embodiments and is also in line with your letter's suggestion of emphasising the literal interpretation of claim 1's 'one of the transmitters within each cell also serving as a gateway for receiving data transmitted from the other data source transmitters within the cell'. Your letter suggests that this indicates a limit of 'at least two transmitters per cell' but it actually indicates 'at least three'; the one transmitter that serves as the gateway plus at least two 'other data source transmitters' from which the gateway receives data. It is not clear to me that a limitation of 'at least three' rather than 'at least two' is intended or indeed necessary but I would need evidence to assure me of the fact that a limitation of 'at least two transmitters' is supported by the original disclosure. It is noted that if one were to seek support from page 6 lines 19-23 and equate the BDAC cell to the defined transmitter and the GDAC cell to the defined cell, the reference to the number of BDACs in a GDAC being immaterial to the invention would mean that an arrangement of one BDAC per GDAC (i.e. one transmitter per cell) would also have to be acceptable and within the scope of the claimed invention, which does not seem to be the case. In addition, it is noted that the 'two transmitters per cell' embodiment is anticipated by two of the citations.

9. One of the wireless transmitters within each cell acts as a cell gateway such that in addition to receiving data from its associated data source(s), it also receives data wirelessly transmitted from the other wireless transmitter(s) within its cell and wirelessly transmits all the received data on, out of the cell, towards the data collection point. A plurality of

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Your ref : AMS.P52428GB
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[Examination Report contd.]

(independent) pathways are employed to transmit data from the data sources either directly to the data collection unit or to one or more relays that relay the data to the data collection unit. Each pathway contains at least one gateway and data is transmitted wirelessly along a pathway via the or each gateway in the pathway, where any gateway-to-gateway transmission within a pathway is point-to-point, i.e. the plurality of pathways are independent of each other by virtue of the fact that no gateway in a pathway, directly receives data from more than one gateway or directly transmits data to more than one gateway (see page 8 lines 14-15).

10. This seems to me to be how the majority of the described embodiments work, although claim 16 and page 6 lines 31-32 suggest embodiments where there are two or more gateways per cell, which clearly fall outside the scope of the above arrangement. However, it is not clear to me that such embodiments are supported as there is no clear disclosure of how the invention would work with two or more gateways per cell. Thus it is my view that the embodiments of claim 16 and page 6 lines 31-32 fall outside the scope of the invention for which protection is currently sought.

Novelty

11. As detailed below, the invention as defined in the independent claims is anticipated. As previously reported, claims 1-13, 16-28, 31-34, 37-41, 44 are either anticipated or rendered obvious by **US 6226601**. In addition, since claim 38 does not require the gateway to be a data source transmitter that receives data from other data source transmitter(s) within its cell, claims 38, 42 & 43 are further anticipated or read onto, for example, by **WO 98/18022, WO 98/07049** and **US 5706250**.

12. Moreover, in terms of the disclosed invention as I understand it, **US 6226601** anticipates embodiments where the independent pathways each contain only one gateway (see your Figure 9). In addition, further searching has found new citations **JP 10031075** and **US 3886494** which anticipate embodiments where each cell contains two transmitters and the cells overlap.

13. **US 6226601** relates to a wireless seismic survey system utilising a multiple-level layered cell topology that may comprise two or more layers/levels (col. 2 lines 51-56 & col. 7 line 65). In US 6226601, seismic data is collected from a plurality of measurement devices (e.g. geophones). Each measurement device is associated with a transmitter, either its own transmitter or the transmitter of a local collection point serving a group of measurement devices, (col. 3 lines 50-59, col. 4 lines 4-11 & col. 6 lines 55-64).

14. The system has a plurality of first level cells such that data from a measurement device located within a first level cell is transmitted, via its associated transmitter, to a Layer 1 hub (col. 3 lines 57-60). The hub may be a specially configured transceiver device or another measurement device with a transceiver (col. 6 lines 53-54 & col. 7 lines 1-16).

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Your ref : AMS.P52428GB
Application No : GB0227293.8

Date of report: 15 February 2007
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[Examination Report contd.]

15. The system also has a plurality of second level cells such that data from a Layer 1 hub located within a second level cell is transmitted to Layer 2 hub (col. 3 lines 60-62), where the Layer 2 hub can be one of the Layer 1 hubs located in the cell (col. 5 lines 51-53).

16. In the terminology of your disclosure, and referring to your Figure 4b, in one respect, the transmitting measurement devices or transmitting local collection points in US 6226601 can be considered to be data sources (305), making the Layer 1 hubs their associated transmitters, i.e. a Layer 1 cell equates to the BDAC shown in your Figure 4b, where the Layer 1 hub is the transmitter (310). In this case, referring to your Figure 3, a Layer 2 cell then equates to your GDAC cell (200) and the Layer 1 hub that acts as the Layer 2 hub by receiving data from the other Layer 1 hubs within the Layer 2 cell, equates to the gateway transmitter (315) of your GDAC cell.

17. Since it is apparent from Figure 10 that the disclosure of US 6226601 does not require complete consolidation of the data before it is transmitted to the collection point (1080), in a two layer embodiment, there may thus be a plurality of Layer 2 hubs each transmitting data to a collection point or collection point relay (col. 3 line 63-col. 4 line 3). This anticipates the embodiment where each of the plurality of pathways contains one gateway (see your Figure 9).

18. In another respect, since a hub can itself be a measurement device that just happens to be linked to a group of associated measurement devices, one might even argue that the Layer 1 hubs in US 6226601 could be viewed as your data sources, the Layer 2 hubs as your transmitters and the Layer 3 hubs as your gateway transmitters (i.e. the layer two cell is your BDAC and the layer 3 cell is your GDAC). With this interpretation, the one gateway per pathway embodiment is again anticipated, with Figure 10 showing half of your Figure 9.

19. The new citations **JP 10031075 & US 3886494** show seismic surveying systems that have a plurality of wireless transmitters, each associated with one or more geophones, where each transmitter is for transmitting the seismic data of its associated geophone(s) towards a central station. The data from the geophones is transmitted towards a central station via a plurality of pathways, where each pathway contains a plurality of transmitters and data is transmitted via each transmitter in the pathway in a point-to-point fashion, i.e. no transmitter in a pathway transmits data directly to more than one other transmitter and no transmitter in a pathway, receives data directly from more than one other transmitter.

20. These two disclosures anticipate your claimed invention if, as your previous letters suggest, your claimed invention encompasses cells with overlapping content, where each cell need only contain two transmitters, one of which acts as the gateway for that cell. JP 10031075 and US 3886494 each show a row of transmitters (and associated data sources) and one may view these as a row of cells, where each cell contains two transmitters and where adjacent cells overlap such that one transmitter is disposed in each overlap, i.e. each transmitter resides in two adjacent cells at any one time, where in one cell the transmitter is

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Application No : GB0227293.8

Date of report: 15 February 2007
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[Examination Report contd.]

acting as the gateway, receiving data from the other transmitter in that cell but in the other cell is acting as the transmitter, transmitting data to the gateway of that cell.

21. The other citations anticipate claim 38. In **WO 98/18022** the disclosed cell access node (CAN 16) is a transmitter and is associated with each geophone/ remote acquisition unit (RAU 10) within its cell 14. Claims 38, 42 & 43 at least are thus anticipated since WO 98/18022 discloses a method where a plurality of seismic data sources (geophone/RAU units 10) are organised into a plurality of cells (14), each cell including a gateway (CAN 16), wherein the gateway (CAN 16) is a transmitter associated with (at least) one data source (RAU 10) and where the method involves transmitting the data from the data sources (10) to a central control unit (12), through a plurality of pathways each containing at least one gateway (16). Figure 1 shows cells that may be considered to be overlapping or interleaved. The wired system of **WO 98/07049** similarly reads onto claim 38, 42 & 43 since the wired seismic systems shown in Figures 3a, 3b & 5 can be considered to show data sources (sensors 10) grouped into cells that may overlap or interleave, with each cell having a gateway transmitter (collector 20) associated with (at least) one data source (10), where data is transmitted to a central location (concentrator 12) via a plurality of pathways each containing at least one gateway (20). In **US 5706250**, a plurality of seismic data acquisition devices (BAn) are organised into a plurality of cells (groups GAn), each cell including a gateway (concentration unit Cn) being a transmitter associated with (at least) one data source (BAn), where data from the data sources (BAn) is transmitted to a central station (I), through a plurality of pathways each containing at least one gateway (Cn). In the wireless embodiment of Figure 1, each pathway contains only one gateway (Cn) but in the embodiment of Figure 4 that discloses a mixed mode system using both wired and wireless transmission, a pathway containing multiple gateways (C1, C2, Ci) is disclosed, where the wired gateway to gateway transmission is point-to-point. This disclosure anticipates claim 38 at least.

Inventive step

22. It seems to me that your disclosed invention is not inventive over the known prior art.

23. The only feature that provides any substantial distinction between your disclosed invention and **US 6226601** is having pathways containing a plurality of gateways, where data is transmitted via each gateway in the pathway and no gateway in a pathway directly receives data from more than one gateway or directly transmits data to more than one gateway. This linear or point-to-point transmission is not disclosed in US 6226601 but it is disclosed in JP 10031075, US 3886494 and thus does not seem inventive.

24. It is accepted that US 6226601 generally teaches data consolidation or concentration, i.e. multihub-to-hub transmission (e.g. see col. 2, lines 10-12 & 52-56). However, Figure 10 shows that complete consolidation is not essential and it is my opinion that a skilled man would consider an adaptation involving hub-to-hub transmission to be merely a matter of cell design, rather than technical inventiveness. This is further supported by the disclosures in JP

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Your ref :	AMS.P52428GB	**Date of report:**	15 February 2007
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[Examination Report contd.]

10031075, US 3886494 and **US 5706250** which show both wireless and wired examples of such linear transmission.

25. The embodiment of your disclosed invention that is distinct from **JP 10031075 & US 3886494** is the one having at least three data source transmitters in each cell, where one data source transmitter in the cell acts as a transmission gateway for the two or more other data source transmitters in the cell. However, the idea of having one seismic collection device acting as a collection point or gateway for two or more similar collection devices is not inventive and both wired and wireless examples are shown in **US 6226601 & US 5706250**.

26. Thus the expansion of the systems shown in JP 10031075 & US 3886494 by means of adding additional seismic transmitters at the sensing sites, where only one transmitter at each site acts at the collection point or gateway, would not seem to involve any technical inventiveness. Such methods of data consolidation are well known and figures 1 and 4 of US 5706250 illustrate that such pathway adaptations would be obvious to a skilled man.

Other matters

27. Please note that the original search has now been topped up (with an extension to IPC/ECLA areas G01V1/00, 1/00B) but in light of the continuing uncertainty over the scope of the invention, further searching may be required following any amendment.

Remote User

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Your Reference: AMS.P52428GB
Application No: GB0227293.8

25 April 2007

Dear Sirs

Patents Act 1977: Examination Report under Section 18(3)

Latest date for reply: **9 May 2007**

I have re-examined your application in response to your agent's letter of 23 April 2007 and enclose two copies of my further examination report.

By the above date you should either file amendments to meet the objections in the enclosed report or make observations on them. If you do not, the application may be refused.

Yours faithfully

Anita Keogh
Examiner

[1]**Use of E-mail:** Please note that e-mail should be used for correspondence only.

UK Intellectual Property Office

For Creativity and Innovation

Your ref:	AMS.P52428GB	**Examiner:**	Anita Keogh
Application No:	GB0227293.8	**Tel:**	01633 814380
Applicant:	WesternGeco Seismic Holdings Limited	**Date of report:**	25 April 2007
Latest date for reply:	9 May 2007	**Page**	1/2

Patents Act 1977
Examination Report under Section 18(3)

Basis of the examination

1. My examination has taken account of the amendments filed with your agent's letter of 23 April 2007.

Added subject matter

2. As discussed in a telephone conversation with Dr. Suckling today, your amended application discloses subject matter which was not present in the original application. Any amendment which extends the original disclosure of an application is not allowable and should be removed or the application may be refused. The additional subject matter I have identified is in claims 1 and 18 and is the reference to transmission 'without consolidation of data'.

3. Your letter states that the application clearly describes that, when a gateway receives data from the gateway of a previous GDAC, the gateway does not consolidate the data from the data sources in the GDAC with the data received from the preceding GDAC but I must respectively disagree. The passage identified as providing support, i.e. page 8, lines 24-26 states, "In this fashion, each gateway 210 receives data transmitted to it, assembles it with its own data, and transmits the resultant data set to the next gateway 210 in the pathway until the data reaches the data collection unit 120". This does not suggest or provide support for transmission 'without consolidation of data'. Furthermore, without a clear description, the exact technical scope of 'consolidation' is unclear and open to interpretation and the identified passage might even be taken to indicate that there is 'consolidation' of data.

4. Thus neither the identified passage, nor the passage discussed over the telephone, i.e. page 11 line 33 – page 12 line 7, provide support for 'without consolidation of data' and I can find nothing else in the application that supports the inclusion of this feature. Moreover, there is nothing in the description to link the feature of non consolidation to the so-called 'independent' pathway and in relation to such a pathway, I maintain the opinion expressed in paragraph 9 of my last report.

5. In addition, I am of the opinion that in the citations, the presence or absence of data 'consolidation' is open to interpretation and so the inclusion of such a feature would not be of use in overcoming the citations.

6. Thus, the amendment made to the independent claims is not allowed as it adds matter and since the rest of your response is based on this amendment, I have not considered the

Your ref : AMS.P52428GB **Date of report:** 25 April 2007
Application No : GB0227293.8 Page 2 / 2

[Examination Report contd.]

remainder of your response in any detail since it is my opinion that the objections and comments in my report of 15 February 2007 remain valid.

[redacted] Remote User

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Your Reference: AMS.P52428GB

24 July 2007

Dear Sir/Madam

PATENTS ACT 1977: PATENTS RULES 1995
NOTIFICATION OF GRANT: PATENT SERIAL NUMBER:GB2395630

1. I am pleased to tell you that your patent application number GB0227293.8 complies with the requirements of the Act and Rules, and that you are therefore granted a patent (for the purposes of Sections 1-23 of the Act) as from the date of this letter.

2. Grant of the patent is expected to be announced in the Patents and Designs Journal on 22 August 2007. In accordance with section 25(1), the patent will be treated for all later sections of the Act as having been granted and as taking effect on that date. The patent specification will be published on the same date, and you will receive the Certificate of Grant for your patent and a copy of the specification shortly afterwards.

3. IMPORTANT - It is essential that you take note of the following information about annual renewal payments:

(i) To keep your patent in force, you must pay the Office an annual renewal fee accompanied by Patents Form 12/77 (which can be obtained from this Office).

(ii) For most patents, the date on which the first renewal fee is due is determined as follows; calculate the fourth anniversary of the date of filing, and the last day of the month in which this anniversary falls is the date on which the first renewal fee is due. Subsequent renewal fees will be due, each year, on the same due date. If you wish, you can pay a renewal fee in the 3-month period before each due date.

[PLEASE TURN OVER]

(iii) In some cases, though, there are special arrangements for the payment of the first renewal fee on a patent. If those special arrangements apply to your patent, you will be given further information when you receive the Certificate of Grant referred to in paragraph 2.

(iv) If any renewal fee is not paid by the due date, a further six months is allowed in which to pay the fee. No additional fee is payable if payment is received by the Office during the first month after the due date, but payment received during the second to sixth months after the due date is subject to an additional fee, currently £24 per month or part of a month overdue.

(v) An example:
For a patent filed on 17 October 2002, the first renewal fee would be due for payment on 31 October 2006. The fee could be paid in advance from 1 August 2006. Subsequent renewal fees would be due on 31 October annually. The first free month of the late payment period would end on 30 November 2006 and if no payment was received by 30 April 2007 the patent would cease.

4. If you would like further information about patent renewal fees, or if you would like us to send you a blank Patents Form 12/77, please telephone our Renewals Section on 01633-814655.

5. Copies of the specification of the granted patent will be placed on sale at the Sales Branch, Concept House, Cardiff Road, Newport, South Wales NP10 8QQ as from the date in paragraph 2 above and for a limited period at the London Front Office, Harmsworth House, 13-15 Bouverie, Street, London, EC4Y 8DP. The copies supplied will have the suffix "B" after the serial number to distinguish the specification of the granted patent from that of the published application.

Yours faithfully

Sean Dennehey

SEAN DENNEHEY
DIRECTOR OF PATENTS

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